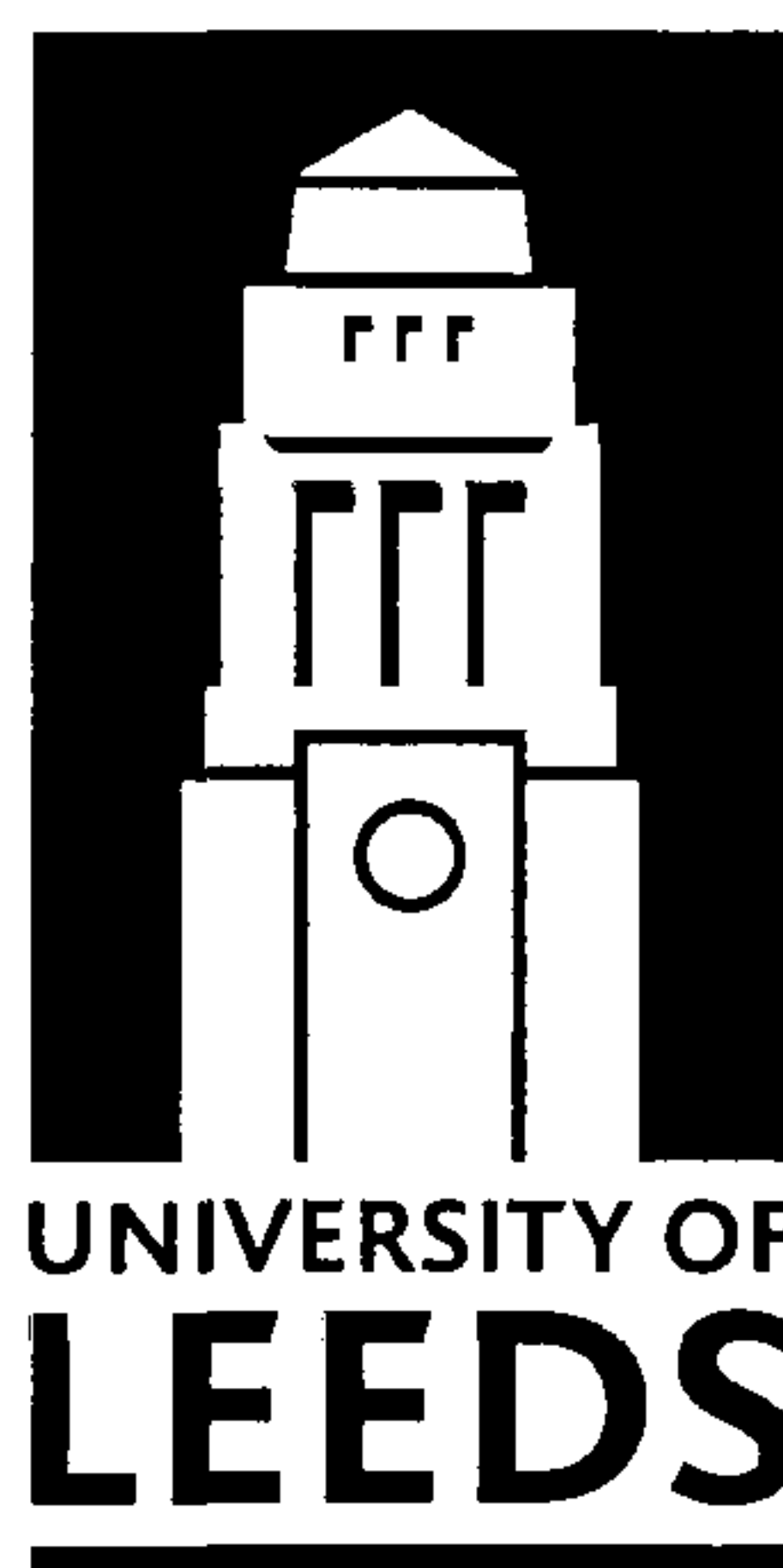


# Moderators and underlying mechanisms of stress-induced eating

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## ABSTRACT

The effect of stress on food intake varies across individuals, according to gender, bodyweight and eating style. However, little is known about the relative importance of these variables in stress-induced eating. Similarly, little research has addressed whether the effect of stress on intake differs according to stressor characteristics and food type. Psychological accounts of stress-induced eating have suggested a change in attentional processing of food stimuli when stressed, but this theory has not yet been directly tested. Physiological accounts of stress-induced eating propose that cortisol secretion during the physiological stress response has an appetitive effect, a theory that has received support from the laboratory, but has not been tested in the field. Six studies are presented in the present thesis, investigating the moderators and underlying mechanisms of stress-induced eating. Studies One and Two used questionnaire and diary methodologies to investigate the moderators of stress and snack intake. Study One indicated that increased intake was more prevalent in females and emotional eaters, and that the intake of crunchy foods particularly increased with stress. Study Two further highlighted that stressor type interacted with eating style, where emotional eaters, external eaters and disinhibitors increased intake in response to physical stressors, and high restrained eaters increased snack intake with work stressors. Studies Three, Four and Five investigated whether a change in attentional processes during stress could account for stress-induced intake in high external eaters. Study Three reported that external eaters increased their attention towards snack food words when stressed, while Study Four reported that external eaters attended towards unhealthy food words when stressed, but only at prolonged exposure times. Study Five did not provide further evidence for the theory, as stressed, external eaters did not attend towards food images. Study Six explored whether cortisol reactivity could account for stress-induced eating, comparing the snack intake of high and low cortisol reactors in response to laboratory and field stressors. The intake of high and low cortisol reactors did not differ in the laboratory. However, high reactors, but not low reactors, showed a positive association between hassles and snack intake in the field. The six studies combined to comprehensively investigate the moderators of stress-induced eating, and test two unexplored accounts of stress-induced eating, using both experimental and survey methodologies.

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## CHAPTER ONE

# STRESS-INDUCED EATING, ITS MODERATORS AND UNDERLYING MECHANISMS: A REVIEW OF THE LITERATURE

The value of a balanced diet for important health outcomes is becoming increasingly apparent, with concerns about overeating, dietary imbalance and consumption of foods protective against illness dominating media reports and government health initiatives. It is now estimated that one third of adults in the UK will be obese by the year 2020, and that, if current trends continue, children of the next generation will have lower life expectancies than their parents (UK DoH Summary of Intelligence on Obesity, 2004). Consequently, overeating and high fat intake are major health concerns. Concurrently, there are worries over undereating of certain foods. A healthy diet is now recognised as the second most important factor (after cutting back on smoking) in cancer prevention, in the reduction of heart disease development and in helping control symptoms of asthma and diabetes (UK DoH 5 a Day Health Benefits, 2003). Such dietary concerns are reflected in the government schemes to provide all members of the public with a personal health trainer, to introduce a coding system about the nutritional composition of individual foods and to supply fruit and vegetable vouchers for low income households (BBC Health News, 16<sup>th</sup> November, 2004). The familiar ‘5 a Day’ government scheme aims to promote the health benefits of consuming five daily portions of fruit and vegetables, and increase the accessibility of these foods for everyone. In targeting children’s diets specifically, it would be almost impossible to have missed celebrity chefs championing the cause for healthier school dinners (Feed me Better Campaign, 2005) and a crackdown on ‘junk food’ advertising between children’s television programmes (Felicity Lawrence, The Guardian, 11<sup>th</sup> November, 2005). It is vital to investigate any threats to a balanced and non-excessive diet, now that we are so aware of its direct and protective effects on health outcomes. The present thesis aims to contribute to a greater understanding of how stress threatens the intake of a balanced diet, by exploring the mechanisms through which stress influences food intake, and the factors that serve to moderate the relationship between stress and eating.

### **1.1 Stress-induced Eating and Health**

Recurring periods of stress are known to adversely impact on cardiovascular, digestive and immune functioning, through repeated activation of the hypothalamic-pituitary-adrenal (HPA) axis (Clow, 2001; Kiecolt-Glaser et al., 2002; Sapolsky, 1998; Wade et al., 2001). Stress has also recently been related to premature cell ageing and increased incidence of cell mutations through the shortening of chromosomal telomeres (Epel et al., 2004). These are the direct physiological effects of stress; physical functioning may also be affected indirectly, through unhealthy behavioural changes associated with stress, including smoking, alcohol consumption and the focus of this thesis, disruptions to usual eating behaviours (Ng & Jeffrey, 2003; Steptoe, 1991).

The association between stress and eating behaviour is well established in the eating pathology literature. Stress and trauma are implicated in the development of both anorexia nervosa and bulimia nervosa (Bennett & Cooper, 1999), and daily stressors are associated with binge eating episodes in individuals with binge eating disorder (Crowther et al., 2001; Vanderlinden et al., 2001; Yacono Freeman & Gil, 2004). Turning towards non-eating-disordered populations, less extreme changes in eating behaviour could result in health problems through a dietary imbalance. The UK Department of Health and the US Department of Health and Human Services advise a diet high in fibre, fruit and vegetables and low in salt, saturated fat and sugar, for protection against health problems including high blood pressure, obesity, diabetes, heart disease and certain cancers (UKDoH, 2004; USDHHS, 2003). Therefore any stress-related disruption in eating behaviour, including an increase or decrease in overall intake, or a change in food choice, could compromise this balance, and consequently health.

### **1.2 General Effects versus Individual Differences Models**

The distinction between the ‘general effects’ and ‘individual differences’ models of stress-induced eating was first described in Greeno and Wing’s (1994) review. The general effects model assumes that stress has the same effect on the eating behaviour of all individuals, and as such investigates the effect on the sample as a whole. In contrast, the individual differences model takes the perspective that certain individual factors moderate the relationship between stress and eating, and so takes



these factors into account when analysing the effect. Broadly speaking, animal research has adopted a general effects approach to the study of stress-induced eating, while research with human volunteers has investigated the characteristics predicting a susceptibility to increased intake. Both animal and human studies are informative about the validity of these two approaches.

### **1.2.1 Animal Studies**

Animal studies of stress-induced eating have typically measured feeding response to a physical stressor, although the effects reported have been contradictory. In one physical stressor paradigm, pinches are administered to the animal's tail, and this has frequently been shown to increase food consumption (e.g. Morley et al., 1986). However, rodents are also reported to increase general gnawing and chewing behaviours with tailpinches rather than eating per se, and it is theorised that this stressor increases gnawing, with food intake increasing as a by-product if the animal is not fully sated (Levine & Morley, 1981). In the restraint stress paradigm, the animal is bound in such a way that all movements except for breathing are restricted. Ely et al. (1997) reported that rats increased intake of sweet foods specifically after chronic, but not acute, restraint stress. Other researchers, however, have found a decrease rather than an increase in intake in response to the restraint stress procedure (Krahn et al., 1990). Increased food intake has also been reported in rats after a cold swim stressor (Vaswani et al., 1983); and in defeated mice following a fight (Teskey et al., 1984), in what may be considered a more ecologically valid stressor paradigm.

Other stress procedures have found evidence that food intake decreases with stress. Krebs et al. (1996) found that rats decreased food intake after exposure to white noise, though they eventually normalised intake to match that of the control rats after multiple stress sessions, by increasing eating speed. Tamashiro et al. (2004) reported a decrease in bodyweight in subordinate mice compared with dominant animals, following the formation of a social hierarchy, which could be attributed to a decrease in food consumption. Mild electrical shocks to the feet (footshocks) have also been shown to decrease food intake in rats (e.g. Sekino et al., 2004). Therefore the direction of the effect of stress on food consumption differs with the stressor paradigm. Stressor intensity may also serve as an important moderator of the stress-eating relationship. Dess (1997) reported that mild stressors (20 electrical shocks to

the tail, or restraint stress) were associated with an increase in intake, while more severe stressors (100 tailshocks) led to a decreased intake. Therefore stressor type and intensity may influence the effect of stress on eating behaviour.

Not all animal studies have looked at the general effects of stress on intake. Macht et al. (2001) investigated individual food intake responses to a white noise stressor in rats. It was reported that individual rats responded differently to the stressor, with approximately one third of the animals decreasing food intake and the other two thirds showing no change in eating behaviour. Furthermore, those rats that ate less when exposed to the stressor displayed an increase in other behaviours associated with stress reactivity, such as increased scanning and grooming. This then also suggests that the differences in food intake response may reflect a variation in general stress reactivity between the animals.

Individual differences in stress-induced eating have been further emphasised by Hagan et al. (2002), in an investigation of the combined effects of dietary restriction (reduction in normal caloric intake) and electric shocks to the feet on food intake. The results showed that there was an increase in the intake of palatable (but not unpalatable) food in the animals exposed to both the caloric restriction and the foot shocks, for up to 24 hours after stress cessation. However, neither of these factors alone was associated with an increased intake. This shows two interesting findings. First, that highly palatable food is more rewarding than low palatable food following stress. This phenomenon is likely related to the release of opiates during physical stressors, since opiates are associated with increasing hedonic value of foods in animals (Yeomans & Gray, 2002). Second, the study suggests that both previous dietary restriction and the electric shock stress need to be implemented for this effect to be observed.

The extent to which animal studies can be generalised to the study of human eating behaviour is questionable, since human eating behaviour arguably involves a greater interplay between biological, psychological and social factors. Despite this criticism, animal studies have shown several important findings. First, the direction of the effect appears to be moderated by the type and severity of the stressor, so that milder stressors are associated with an increased intake, and severe stressors with a decreased intake. Second, individual differences in eating response are observable



in non-humans, which could be attributed to variability in general stress reactivity or prior dietary restriction. Third, stress-induced differences in feeding are dependent on the type of food available. These findings support the view that an individual differences approach may be more appropriate in the study of stress-induced eating than the general effects model even when studying animals.

### **1.2.2 Human Studies**

Three studies have investigated the general effects of stress on eating behaviour without considering the possible intervening role of other factors; all three studies taking advantage of naturally occurring stressful situations. Michaud et al. (1990) measured food intake in response to examination stress in high school students. The results showed that there was a slight increase in fat intake on the day of the exam, suggesting an increase in intake with stress, at least for high fat foods. However, it is questionable whether high school students have as much control over food intake as adults. Macht et al. (2005) measured food intake and motivations to eat in undergraduate students during an exam period, comparing students with and without exams. Although the exam students reported a greater motivation to eat for distraction, there was no difference in actual food intake between the two groups, in contrast to the Michaud et al. findings.

In the third general effects study, Bellisle et al. (1990) compared the lunchtime intake of men on the day of surgery with that at a later hospital visit. These results showed no difference in food intake between the two days, in concordance with Macht et al.'s (2005) findings. It is worth taking into account that both intake measures took place in the hospital environment, and that both visits may have been stressful for the patients. Secondly, the patients were made aware that their lunch intake was being monitored, which raises issues about the authenticity of their subsequent eating behaviour. Overall the three studies offer conflicting results, with two studies reporting no effect of stress on food intake, and one reporting an increase in consumed fat. All three general effects studies have maximised the validity of the stressor by studying eating behaviour in response to naturally occurring events. The analysis of whole samples, however, means that individual eating changes could have been masked, contributing to the null or conflicting effects.

The motivation for taking account of individual differences in stress-induced eating is further strengthened by survey responses. Willenbring et al. (1986) found that 44% of a group of obese participants reported eating more when stressed, while 48% felt they ate less, and 8% reported no change. Similarly, Oliver and Wardle (1999) asked participants how they felt that their food intake changed with stress. The respondents who reported eating more or less were represented in fairly equal proportions, while approximately one fifth felt that there were no changes in their eating behaviours. Individual differences in eating response are therefore apparent in self-report data. These findings further suggest that the minority of people perceive no changes in intake, while the majority are fairly evenly divided into those who feel they eat more and those who feel that they eat less under stress. Overall human as well as animal studies support the individual differences model for stress-induced eating over general effects.

### **1.3 Moderators of the Stress-Eating Relationship**

The research reviewed so far illustrates that eating response to stress varies between individuals. This section will review the role of individual differences variables that serve to moderate the stress-eating relationship, and as such account for the differences in eating patterns observed.

#### **1.3.1 Bodyweight**

Bodyweight was one of the first moderators of the stress-eating relationship to be identified, with both laboratory and naturalistic studies highlighting a difference between normal weight and overweight individuals (see Ganley, 1989, for a review of emotion-induced eating in the obese). Schachter et al. (1968) looked at the effects of anxiety (threat of painful electrical shocks) on the number of crackers consumed by normal weight and obese participants. They found that normal weight individuals ate more when calm than when anxious, but that the obese participants ate the same amount in both conditions. In another laboratory study, McKenna (1972) reported also that normal weight participants ate less in the high anxiety condition (threat of painful physiological measurements). In contrast to the Schachter et al. study, the obese participants increased food intake in the high anxiety condition. Pine (1985) also reported that obese participants increased food



intake in a high anxiety condition compared with a low anxiety condition, in support of McKenna.

The above laboratory studies suggest that there is a difference in the effect of stress on the food intake in obese and normal weight participants, although not all studies have supported this difference. Abramson and Wunderlich (1972) investigated how the threat of painful shocks, and undesirable false feedback about interpersonal qualities would affect eating behaviour. They found that neither stressor showed any difference in the amount eaten by obese participants, compared with those in the non-stressed condition. There was also no relationship between anxiety and amount consumed in either the obese or normal weight groups. It is unclear why this study found no moderating effect of obesity, in contrast to the other laboratory studies. It is possible that the type of food offered (i.e. crackers) was not particularly appealing to the participants, and may not be the type of food usually chosen when stressed. The Schachter et al. (1968) study also used crackers as a test food, and did not find a difference in the eating behaviour of the obese participants between high and low anxiety conditions, whereas chocolate cookies were offered in the McKenna (1972) study, and peanuts in Pine's (1985) study, which may be more appealing or palatable to participants.

Another factor that could cause inconsistencies in findings is the participants' level of obesity. Nisbett (1972) argues that each individual possesses a biologically determined ideal bodyweight, or 'set point', based on his or her natural level of adipose tissue. The theory suggests a strong physiological drive to reach or maintain the set weight, so that individuals who are not meeting their weight level are in a state of hunger. Furthermore, there exists a wide inter-individual variability in set points, meaning that individuals who have the same bodyweight may differ greatly in levels of discrepancy between their actual bodyweight and their 'set point' weight. It could be that level of obesity as defined by this discrepancy influences the relationship between stress and eating, rather than bodyweight itself. However, on a practical level, it would be exceedingly difficult to measure the body's set point. Therefore differences between laboratory findings regarding the moderating role of bodyweight in stress-induced eating may be partially due to differences in the type of food offered and participants' level of obesity.

Naturalistic and self-report studies have also shown increased intake in overweight individuals. Geliebter and Aversa (2002) conducted a questionnaire study, with underweight, normal weight and overweight participants. The overweight participants reported eating more when experiencing negative emotions and situations, including anxiety and pressure, compared with the normal weight and underweight groups. A diary study of food intake and mood in obese participants revealed that meals were larger when the participants were in a negative rather than a neutral mood (Patel & Schlundt, 2001). These findings provide evidence that obese individuals increase food intake under stress. Naturalistic and self-report studies also show evidence of divergent effects of stress on eating between overweight and normal weight individuals. Lowe and Fisher (1983) reported that obese college students were more likely to increase consumption of snacks in response to emotional arousal, according to daily records of mood and food intake. Conversely, the normal weight participants showed a slight decrease in the number of snacks consumed when in a negative mood. Slochower et al. (1981) reported that obese undergraduate students increased their intake during an examination period, when subjective anxiety was also increased. The normal weight students, however, decreased overall intake. These reports of hypophagia in normal weight participants and hyperphagia in obese participants under stress correspond with the laboratory findings of McKenna (1972). To summarise, the majority of laboratory, naturalistic and self-report studies support a moderating role of bodyweight in the stress-eating relationship, and more specifically they indicate that overweight individuals increase intake when stressed and normal weight individuals decrease food intake.

### **1.3.2 Gender**

Most studies have not investigated the moderating effect of gender, but reports suggest that stress-induced eating is more prevalent among females. For example, Grunberg and Straub (1992) studied the impact of emotionally arousing film on eating, compared with a neutral film. The researchers reported that males significantly decreased food intake in response to the stressful film, while females showed a trend towards increased consumption. The Michaud et al. (1990) study described earlier also reported that examination stress affected energy intake to a greater extent in girls. In contrast, Stone and Brownell (1994) found that females started reporting that they ate less than usual at a lower intensity of stress than did



males. Since Stone and Brownell noted differences in response according to self-reported intensity of the stressors, it may be that the conflicting findings are due to the variation in intensity of stress between these studies.

However, other studies have also shown few differences between males and females. Weinstein et al. (1997) found no difference in the number of males and females who reported themselves as eating more or less when stressed. Turning to empirical data, Conner et al. (1999) found no effect of gender in the relationship between daily hassles and snack intake in a field study, and Pine (1985) found no differences between males and females' intake in response to the threat of electrical shocks in the laboratory. It is therefore unclear whether gender really plays a strong moderating role, and it could be that variations between males and females along the dimensions of other moderator variables account for any effect of gender.

### **1.3.3 Emotional Eating Style**

Emotional eating style describes a tendency to eat in response to any emotional arousal. The concept of emotional eating is derived from psychosomatic theory (Kaplan & Kaplan, 1957), which aimed to explain why certain individuals develop obesity. According to psychosomatic theory, certain individuals are unable to distinguish between the physiological states of emotional arousal and hunger, particularly the obese. This inability to discriminate between the two states may arise during childhood, if parents also offer a child food in response to emotional signals (Bruch, 1961). Consequently, emotional arousal gives these 'emotional eaters' the urge to eat even during adulthood, forming a coping mechanism for such individuals (Kaplan & Kaplan, 1957). There is a reasonable level of support for psychosomatic theory, to the extent that obesity is related to emotional eating. In a review of the obesity literature, Ganley (1989) reports that emotional eating style is very common among overweight individuals, from mild to severe obesity. Even in children, emotional eating has been reported to be greater among the obese (Braet & Van Strien, 1997). In further support, Van Strien et al. (1986b) found that negative life events were associated with weight gain in high emotional eaters, but not low emotional eaters. This suggests that emotional eating could be partly responsible for obesity as the psychosomatic theory proposes, but this effect only existed for the

males in the sample. Therefore there is some support for the basis of emotional eating in the obese.

The psychosomatic theory would predict that those high in emotional eating increase their food intake when stressed, as a mechanism of coping. Van Strien et al. (1995) reported that within a sample of undergraduate students, emotional eating was highly correlated with both emotional distress and regular overeating, thus supporting the view that overeating is associated with emotional arousal among high emotional eaters. In a laboratory study, Oliver et al. (2000) found that emotional eaters in the stress condition (performance of a presentation) had a higher energy intake than those in the control condition or non-emotional eaters. Similarly, Van Strien et al. (2000) found that emotional eating predicted ice cream consumption following a stressor in the laboratory. However, Conner et al. (1999) failed to find a moderating effect of emotional eating scores on the relationship between daily hassles and snacks consumed. Overall, the evidence for emotional eating as a moderator of the stress-eating relationship is strong. Furthermore, a strong relationship has been found between emotional eating style and obesity, as psychosomatic theory would predict (e.g. Lowe & Fisher, 1983) so it is possible that emotional eating accounts for some of the moderating role of bodyweight.

#### **1.3.4 External Eating Style**

Human appetite is influenced by both internal hunger state, perceived through low blood sugar and gastric movements, and external eating cues, such as the sight or smell of food (Schachter, 1971; Schachter et al., 1968). However, individuals vary in their reliance upon each type of cue (Marcelino et al., 2001). Individuals described as having an external eating style rely heavily on these external eating cues including social context, taste and visual appeal (McKenna, 1972), and are relatively unaware of internal hunger state (Schachter et al., 1968). Those who do not react strongly to external or environmental eating cues are sometimes labelled internal eaters. Like emotional eating style, Schachter et al. (1968) introduced the concept of external eating style in an attempt to explain why certain individuals become obese. This theory proposes that certain individuals develop a reliance on external eating cues, by eating at times that do not correspond with physiological hunger signals, hence dissociating internal hunger from food intake. Jansen et al.



(2003) has further proposed that the relationship between external cues and food intake develops in childhood through conditioning, if parents encourage their children to eat in situations where any food is present. Certainly, there is evidence that parental presence affects eating in obese children, but not normal-weight children, so this characteristic may emerge in childhood (Laessle et al., 2001).

Schachter et al.'s (1968) own findings support externality theory to an extent, by demonstrating that obese individuals do not eat less when anxious (when gastric physiological symptoms are suppressed) or after they have already eaten, which does suggest a lack of awareness of internal hunger state. A further test of externality theory is whether obese individuals do in fact eat in response to environmental eating cues. According to their parents, obese children eat in response to external cues and not hunger level (Braet & Van Strien, 1997). These researchers point out that the child's obesity may magnify the impression that the children eat when they are not hungry, and so parental judgements may be open to bias. However, further support is provided by reports that obese adults work harder to gain food when the food reward is visible, while normal weight participants are unaffected by the presence or absence of the cue (Schachter, 1971). This certainly suggests that the food cue increases the desire to eat in obese individuals.

Externality theory further predicts that obese individuals should be more sensitive to the external qualities of food. This has been supported in empirical studies. For example, Decke (1971) found that obese individuals drank more of a highly palatable milkshake than normal participants, but less of an unpalatable milkshake (laced with quinine) than those of normal-weight. However, McKenna (1972) found that the appearance of food (i.e. appetising or non-appetising) did not affect the amount eaten in obese participants, suggesting that taste may be a more important cue than visual appeal. It should also be noted that external eating is not restricted to obese populations, as binge episodes in those with binge eating disorder are seemingly triggered by exposure to food cues (Jansen, 1998), and binge eating disorder is strongly related to external eating (Pinaquy et al., 2003). Student samples show a wide range in scores of self-reported external eating style (e.g. Conner et al., 1999).

With respect to the relationship between stress and eating, Schachter et al. (1968) predicted that external eaters should eat the same amount of food regardless of their stress level, and this was supported by their own findings. Unlike emotional eaters, external eaters do not purportedly associate eating with emotional arousal, as they are unaware of internal hunger level. But it has since been reported that high external eaters may actually increase their food intake when stressed. For example, Conner et al. (1999) found that externality plays a strong role in moderating the relationship between daily hassles and eating. Those high in external eating increased snack intake with high levels of hassles, whereas those low in external eating showed no change in eating pattern with low and high levels of hassles. Cross-sectional data also show strong associations between binge eating, stress and external eating scores (Pinaquy et al., 2003). While the original externality theory cannot account for this finding, Jansen et al.'s (2003) explanation of excessive eating does allow for increased intake with stress, if emotional states have been frequently paired with food intake and stimuli in these individuals. This finding is also consistent with the argument that stress, or indeed any form of arousal, increases awareness of external stimuli including food (Heatherton & Baumeister, 1991; Robbins & Fray, 1980), which would be expected to trigger eating in external eaters. Evidence does seem to suggest that external eaters increase food consumption when stressed (Conner et al., 1999), which may reflect an increased awareness of environmental stimuli. However, research has not actually investigated whether external eaters do show a change in awareness or attention towards food stimuli when stressed, as a test of Heatherton and Baumeister's (1991) conjecture. As with emotional eating, the moderating role of bodyweight could be partially due to its relationship with external eating style.

### **1.3.5 Restrained Eating Style**

Restrained eating style is characterised by a conscious effort to keep weight below its natural level, but without great success<sup>1</sup>. Restraint theory, unlike psychosomatic and externality theory, proposes that overeating is due to dieting (restraint) rather than vice versa (Polivy & Herman, 1985). Restrained individuals attempt to keep weight below its natural point (c.f. Nisbett's set point theory, 1972) by consciously

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<sup>1</sup> Although researchers differ in their meaning of restraint, Herman's research team originally conceptualised restrained eaters as unsuccessful dieters



eating less, leaving the individual in a state of chronic physiological hunger (Herman & Mack, 1975). The normal relationship between internal hunger and food intake may be uncoupled if intake is restricted when hungry (Tuschl, 1990), meaning that restrained eaters may not be aware of internal hunger state, just as psychosomatic and externality theories predicted in the obese. Under normal circumstances, unrestrained eaters consume more than restrained eaters, as would be expected, and restrained eaters reportedly eat a healthier diet than unrestrained eaters (Contento et al., 2005; Mitchell & Epstein, 1996; Rideout et al., 2004). However, dieting does not actually appear to correlate with weight loss over time (Stice, 1998). The disassociation of intake from hunger level coupled with a biological demand for food means that when inhibitions are diminished there is a high likelihood of overeating in restrained eaters.

Counterregulation describes a tendency for restrained eaters to increase food intake, having previously been required to consume a large amount of high-calorie food or drink (Polivy & Herman, 1985). Herman and Mack first demonstrated counterregulation in restrained eaters in 1975, by investigating the amount of ice cream eaten in a 'taste test' by undergraduate students after consuming two, one or no milkshakes (labelled a 'preload'). In such taste test paradigms, the participant is informed that after rating the test food, he or she can eat as much of the remainder as wanted, with the foods weighed by the experimenter before and after. The results showed that the low restraint group decreased their ice cream intake in accordance with the increasing size of the milkshake preload. Those individuals high in restraint, however, ate more of the ice cream after eating the milkshake preload, failing to take into account the energy already consumed in the milkshake or to maintain their diets. Although other researchers have reported that restrained eaters actually non-regulate their calorie intake, rather than counterregulate, by eating the same amount in the preload condition rather than more (e.g. Jansen et al., 1988; Ruderman & Christensen, 1983).

It has also been reported that the counterregulation effect is more strongly seen in restrained eaters when the preload is perceived as high in calories regardless of actual caloric value (Polivy, 1976). However, Knight and Boland (1989) found that the perception of a food as 'forbidden' by a diet was more greatly associated with

counterregulation than the perceived number of calories in the preload. Whether a food is considered high in calories or forbidden, both these findings suggest that overeating occurs after the participant perceives a loss of control over the diet after the preload, and subsequently continues to break the dietary restrictions. This is also termed the ‘what the hell effect’ (Herman & Polivy, 1975). In further support of the role of control, Rotenberg and Flood (2000) found that counterregulation in restrained eaters was mediated by an external locus of control for indulgent food consumption. However, Jansen et al. (1988) found no evidence that self-reported cognitions about loss of dietary control or disinhibition were associated with counterregulatory behaviour in restrained eaters. This does not necessarily mean that such cognitions are not present, though, as this processing may be unconscious (Rotenberg et al., 2005). A further interesting finding is that even the anticipation of a preload appears to influence eating behaviour, so that restrained eaters are found to increase, and unrestrained eaters to decrease their food intake (Ruderman et al., 1985).

Research has since shown that an overeating response is not specific to preloading, as stress also serves as a disinhibitor in restrained eaters. Herman and Polivy (1975) have reported that restrained eaters increase food intake when threatened with painful electric shocks, though the intake of unrestrained eaters is unaffected. Studies have also demonstrated that the anxiety associated with a frightening film is sufficient to increase intake in restrained, but not unrestrained, eaters (Cools et al., 1992; Schotte et al., 1990). This effect is not limited to laboratory studies. Wardle et al. (2000) reported that energy intake increased with work stress in department store workers high in dietary restraint, but this was not the case for unrestrained workers. However, Pollard et al. (1995) and O’Connor and O’Connor (2004) found no evidence for a moderating role of dietary restraint in the relationship between student exam stress and food intake. There is also evidence that the restraint effect is less robust when a variety of test foods are offered, rather than the availability of ice cream alone (Shapiro & Anderson, 2005). This does suggest that the effect may be somewhat restricted to the traditional taste test paradigm.

Herman and Polivy (1975) argue that dietary restraint accounts for differences observed between obese and normal weight groups in terms of stress-induced eating.



There is evidence of a close association between the two variables, as restrained women tend to show a greater gain in bodyweight in a year than do unrestrained women, and obese individuals score more highly on cognitive restraint than non-obese individuals (Ardovini et al., 1999; Beiseigel & Nickols-Richardson, 2004; Klesges et al., 1992). While it seems counterintuitive for restrained eaters to weigh more than unrestrained, restraint theory can account for this as disinhibition prevents significant weight loss, and because obese individuals are typically chronic and unsuccessful dieters (Polivy et al., 1978). There is also evidence of lower energy expenditure in restrained eaters (Tuschl, 1990), and a more efficient metabolism for consumed calories (Polivy & Herman, 1985), which would explain why the net energy balance is positive.

Baucom and Aiken (1981) investigated the amount consumed by undergraduates following a task failure stressor, and found that dieters consumed more than non-dieters after the mood induction. This was the case for both obese and non-obese participants, suggesting that dietary restraint may be the more important factor in predicting stress-induced eating. Similarly, Ruderman and Wilson (1979) reported that restraint was a more significant predictor of counterregulatory behaviour than obesity; although interestingly, restraint appeared to have more of an effect on eating behaviour for normal weight than obese individuals. Costanzo et al. (2001) found that restraint explained some of the relationship between emotional arousal and overeating in obese participants. However, a relationship between negative arousal and eating still emerged after controlling for restraint, so it may be that restraint does not completely account for the moderating effect of bodyweight, and that other factors further play a role.

Restraint theory also predicts a close association between restraint and external eating style. It is theorised that the conscious control of intake means that eating and physiological hunger fall out of synchrony, and consequently, restrained eaters rely more heavily on external eating cues (Herman & Mack, 1975; Polivy et al., 1978). It is argued that this may develop as part of a biological mechanism to restore weight to its desired natural level, or set-point, (Polivy & Herman, 1985) referring to Nisbett's (1972) theory. Alternatively, restrained eaters may develop a conditioned physiological response to certain food cues due to previous binge eating episodes



(Jansen, 1998; Nederkoorn & Jansen, 2002). Many researchers have indeed found a strong correlation between external eating style and restrained eating (e.g. Braet & Van Strien, 1997); although others have found a negative association (Heaven et al., 2001), suggesting that not all restrained eaters rely on external eating cues.

There is also empirical evidence that restrained eaters react strongly to external food cues. Klajner et al. (1981) found that restrained eaters salivated more than unrestrained eaters in response to visual and olfactory food cues. Brunstrom et al. (2004) also reported that restrained eaters salivate in response to pizza exposure, so there is evidence of a physiological response to food cues in restrained eaters. However, Bulik et al. (1996) reported no evidence of greater salivation to food cues in restrained eaters. Findings also suggest that restrained eaters show a behavioural response to food cues, by overeating. Fedoroff et al. (1997) reported that in a non-stressful situation, restrained eaters overeat when exposed to food cues (thoughts and aroma of pizza), which does suggest that externality could form a bridge between restraint and disinhibition as Herman and Mack (1975) proposed. In investigating this finding further, Fedoroff et al. (2003) have reported that restrained eaters eat more of the food that has been cued (though not actually consumed), rather than food in general, suggesting that the external cues may prompt the individual to specifically eat the targeted food. In contrast, Nederkoorn and Jansen (2002) found that unrestrained eaters were actually more physiologically reactive to food cues than restrained. Slochower (1980) argues that restrained eaters may develop an external eating style specifically when anxious. However Polivy et al. (1994) found no evidence that restrained eaters were more sensitive to the taste quality of cookies when stressed, suggesting no evidence of a greater awareness of external food cues under stress.

One final issue with dietary restraint is that it may not be a unitary construct. Firstly, there appears to be a difference between dieters and restrained eaters, although restraint theory does not make a clear distinction between the two groups. Interestingly, dieters per se do not exhibit counterregulatory behaviour, and respond to a preload by eating less, rather than more, of a test food (Lowe, 1995). This highlights a necessary distinction between restrained eaters who are characteristically unsuccessful dieters (Heatherton et al., 1988), and dieters in

general. Restrained eating and dieting could also interact so that those most at risk of counterregulatory eating are restrained non-dieters who impose fewer restrictions on food intake than restrained eaters who are currently dieting (Lowe & Timko, 2004). Laboratory studies have shown that restrained eaters only show counterregulatory behaviour if they also score highly on tendency towards disinhibited eating (Ouwens et al., 2003; Van Strien et al., 2000; Westenhoefer et al., 1994). Weinstein et al. (1997) found that disinhibition was a better predictor of stress-induced eating in women than cognitive restraint, and Yeomans et al. (2004) reported that highly restrained eaters who were low in disinhibition were less susceptible to overeating after tasting palatable food than highly restrained eaters scoring high on disinhibition. Therefore, a clear difference between successful dieters and Herman and Mack's (1975) conceptualisation of restrained eaters is the tendency to disinhibit intake.

This difference in overeating behaviour between dieter groups may be understood in terms of Westenhoefer et al.'s (1999) distinction between rigid and flexible restraint. Individuals in the former group keep a very tight control over intake, while those in the second group allow dietary lapses and compensate for them later. According to Westenhoefer et al. the rigid control group are more susceptible to disinhibition as the lapse is viewed as more devastating for their diet, while the flexible group are unaffected by a preload. Evidence that rigid control and disinhibition tendency are critical variables in overeating can be found from both laboratory and self-report studies. Timko and Perone (2005) reported that rigid control was associated with a higher BMI and self-report disinhibition, while flexible control was associated with low disinhibition and low BMI in female students. Therefore the rigid/flexible control distinction may be valid in predicting counterregulatory behaviours, and that restraint theory only applies to the rigid control restrained group rather than all dieters.

### **1.3.6 Personality Factors**

Evidence already points to a link between personality and eating behaviours. First, eating disorders are strongly related to personality traits. The personality traits anxiety and neuroticism are associated with anorexia and bulimia, and implicated in their development (Ghaderi & Scott, 2000; Raevuori, 2002). A high sensation-



seeking score has also been linked to binge eating (Kane et al., 2004). A link between personality and eating disorders is also shown by a high correlation between eating disorders and personality disorders (Godt, 2002). Second, food preferences may be affected by personality. Goldberg and Strycker (2002) found that eating low fat foods was associated with conscientiousness, and high fibre consumption with openness to experience in a large American sample. Potts and Wardle (1998) reported that food pickiness and phobias about new foods were related to low levels of sensation seeking. So far, little research has addressed the relationship between personality and stress-induced eating changes; however there are indications that emotional reactivity and neuroticism, perfectionism and conscientiousness play a role.

It is possible that those who eat more in response to stress have higher anxiety levels than those who eat less or show no change. Pollard et al. (1995) reported that students high in trait anxiety showed an increase in food intake during a stressful exam period, while those low in trait anxiety showed the opposite pattern. This finding suggests that trait anxiety plays a moderating role; but eating response to stress could also depend on anxiety reactivity level, where those with a greater sensitivity to stressful situations increase food intake. Such a theory would fit with Schachter's (1971) proposal that external eating is only one aspect of a more general sensitivity to external stimuli in the obese, which also includes a hypersensitivity to stressors. Polivy et al. (1978) found that restrained eaters were more reactive to emotional pictures than non-restrained, which suggests greater reactivity in restrained eaters.

It could be argued that this over-responsiveness to stress especially contributes to the effect of stress on eating in the obese, who are reportedly more likely to be emotional eaters (e.g. Ganley, 1989). There is evidence from laboratory studies that the obese are more reactive to emotional events and stimuli (Abramson & Wunderlich, 1972; Schachter et al., 1968). Lowe and Fisher (1983) reported that obese individuals were seemingly more reactive to stressors than normal weight individuals, when studied in a natural environment. As a caveat to emotional reactivity research, the level of available social support could affect the stress and eating relationship through its associations with emotional response and coping



resources. DeLongis et al. (1988) reported that there are more mood and health disturbances in response to stress in individuals with low social support. The Pollard et al. (1995) study also found that low social support contributed to the effect of stress on eating in those with high trait anxiety. Emotional stability level, or neuroticism, as well as social support level, may provide an avenue for future investigations of stress and eating relationship moderators.

Perfectionism has been conceptualised by Hewitt and Flett (1991) as encompassing three dimensions, namely self-oriented (setting standards for oneself), other-oriented (setting standards for significant others) and socially prescribed perfectionism (a desire to meet standards set by significant others). Perfectionism has been strongly associated with anorexia nervosa (Franco-Paredes et al., 2005); self-oriented and socially prescribed perfectionism in particular (Cockell et al., 2002). Research has also shown perfectionism to be high among dieters (Emmons, 1994) and restrained eaters (e.g. Slade & Dewey, 1986). McLaren et al. (2001) reported that all three dimensions of perfectionism were positively associated with dietary restraint. It seems intuitively plausible that perfectionists would be more likely to restrict food intake in order to maintain or reach a particular weight, particularly for those high in socially prescribed perfectionism, who are presumably trying to adhere to societal standards of body size. Conversely, it has also been proposed that perfectionist attitudes are also responsible for the disinhibition effect in restrained eaters, as there seems no point in restricting food intake once the diet has already been violated (Ruderman, 1985). It should be noted that other researchers have found no correlation between the two constructs perfectionism and restraint (e.g. Griffiths et al., 2000). Overall there is evidence that perfectionism is related to restraint, and could therefore be linked to stress-induced eating through this association with restrained eating.

As with perfectionism, little research has addressed the moderating role of conscientiousness in stress-induced eating. However, there is evidence of an association between conscientiousness and eating style variables, as emotional and external eaters are reported to be low in conscientiousness (Heaven et al., 2001). Conscientiousness is also linked to health behaviours (Friedman et al., 1995), with evidence of more unhealthy food choices in low conscientious individuals (Bogg &

Roberts, 2004). In a direct measure of the moderating role of conscientiousness in stress-related eating, O'Connor and O'Connor (2004) found that low conscientious individuals who were also trying to lose weight or scored highly in self-oriented perfectionism increased snack intake during an examination period. This suggests that conscientiousness may affect the relationship between stress and eating in interaction with other eating style and personality variables. Research has not fully addressed the influence of conscientiousness, but evidence does tentatively suggest a role for this personality variable.

#### **1.4 Methodological Differences**

Methodological differences between studies may also impact on any conclusions drawn about stress-induced eating. Three main areas of methodological concern are the eating style scales employed between studies, the measurement environment, and the type of stressor employed.

The discrepancy between different eating style scales is a particular issue for the measurement of dietary restraint. This construct is typically measured using the Restraint Scale (RS; Herman & Polivy, 1980), the Three Factor Eating Questionnaire (TFEQ; Stunkard & Messick, 1985) or the Dutch Eating Behaviour Questionnaire (DEBQ; Van Strien et al., 1986a). Westenhoefer et al. (1994) and Van Strien et al. (2000) have observed that studies are more likely to report that restrained eaters disinhibit food intake when the Restraint Scale is used, compared with the use of the other two major measures. Therefore it is questionable whether all three scales are indeed measuring the same construct. In an investigation of the relationships between the three main scales, Laessle et al. (1989) reported that all three were significantly correlated, but that the DEBQ was more strongly correlated with the RS than was the TFEQ, and that the strongest correlation was between the TFEQ and DEBQ scores. Looking at the individual scale items, the Restraint Scale does appear to contain questions that directly pertain to disinhibition, rather than restraint per se (e.g. 'Do you eat sensibly in front of others and splurge alone?' and 'Do you have feelings of guilt after overeating?'), while the DEBQ and TFEQ restraint scales select more successful dieters as high scorers (Ricciardelli & Williams, 1997). It is not surprising then that studies using different scales find different effects, and that investigations using the RS measure are more likely to find



a disinhibition effect in restrained eaters. Furthermore, there is an issue with participants giving socially desirable responses. Allison et al. (1992) report that it is more difficult to provide socially desirable responses with the restrained eating subscale of the TFEQ than with the other two restraint scales. Interestingly, Stice et al. (2004) argue that restraint scales in general show a poor correlation with actual food intake, meaning that the validity of all three measures is questionable.

The second methodological difference between studies concerns the measurement setting, i.e. whether the study is conducted in the laboratory or the field. A problem with field investigations of stress-induced eating (e.g. food and mood diary studies) is that eating behaviours are likely to be influenced by many other factors, such as lifestyle and social commitments. As with questionnaire data, socially desirable responding in daily or weekly records may pose a problem for self-report data (Anderson et al., 2001); although an investigation by Legg et al. (2000) found that recordings did not appear to be influenced by the rationale provided. There is also an issue with inaccuracies in intake recordings in diary studies (Oliver & Wardle, 1999), especially for highly restrained women (Bathalon et al., 2000). However, studies have shown support for stress-induced eating in the field. Steptoe et al. (1998) reported that nurses and teachers ate a greater amount of fast food during high stress weeks compared with periods of low stress. Wardle et al. (2000) found that department store workers had a greater energy intake during a period of high work stress, compared with a week of lower work stress. Therefore, it seems that eating behaviours are also susceptible to changes with work-related stressors, and that the stress-induced eating phenomenon is not limited to laboratory paradigms.

Laboratory studies afford greater control of extraneous variables, and allow an objective, direct measure of food intake, but there are obvious concerns with the artificiality of both the stressor and the eating behaviour observed. Laboratory studies typically involve acute stressors, such as the threat of shocks or watching a scary film. These stressors are not likely to compare with acute stressors, and certainly not the chronic or accumulated stressors, that are encountered in everyday life. Similarly, eating behaviour may be inhibited by the artificiality of the laboratory setting and the smaller range of food choices, and as such may not reflect eating behaviour in natural and familiar environments. Thus, the use of a laboratory



methodology could be expected to affect the reported relationship between stress and eating, and it would be beneficial for future research to employ diary-based naturalistic study designs to overcome the contrived nature of laboratory-based paradigms and complement the wealth of research from the laboratory.

The type of stressor employed could also affect the stress and eating relationship, as animal studies would suggest. Some laboratory studies have used intense anxiety-inducing stressors, such as the threat of electric shocks or a frightening film (e.g. Cools et al., 1992; Schachter et al., 1968). Other studies have employed more socially based stress manipulations, including confrontation and ostracism (e.g. Oliver et al., 2001). Such differences in stress operationalisation could impact on the findings. This possibility has been measured directly by Heatherton et al. (1991), who reported a difference in eating responses between a physical stressor (anticipated electric shocks) and an ego threatening stressor (failure at an insoluble task or an anticipated speech in front of an audience), in restrained and unrestrained eaters. For the physical stressor, unrestrained participants significantly decreased intake, and restrained eaters showed a slight increase. For the ego threatening stressors, the restrained eaters significantly increased their food intake, but the intake of unrestrained individuals was not significantly altered. Accordingly, the researchers argue that the stressor might need to contain an ego-threatening element for restrained eaters to disinhibit, since these stressors involve emotional rather than physiological arousal.

One issue with this argument is that interpersonal stressors are also found to lead to disinhibited eating in susceptible populations. Tanofsky-Kraff et al. (2000) found that restrained eaters increased ice cream intake after an interpersonal ostracism stressor, and to a greater extent than following the ego threat stressor conditions. Similarly, Oliver et al. (2001) reported that high disinhibitors who were the target of either ostracism or an argument increased their intake. This again suggests that an ego-threatening stress element may not be crucial, but that social stressors also induce overeating. However, it could be argued that arguments and ostracism manipulations also have an adverse effect on self-esteem, and as such pose an ego threat to participants. The importance of ego involvement has also been contested by Schotte (1992), who pointed out that watching frightening films also leads to

disinhibited eating. The rejoinder to this argument, however, is that films encourage individuals to 'escape' from self-awareness, like ego threat stressors, which then facilitates overeating (Heatherton et al., 1992).

Evidence also suggests that stress-induced eating is more likely to occur after uncontrollable stressors (Slochower et al., 1981). In a direct manipulation of this effect, Slochower and Kaplan (1980) investigated the impact of perceived controllability of a stressor and labelling its source, on intake in obese and normal weight participants. The participants in the high anxiety condition were exposed to a sound recording of a very fast heart rate, and were led to believe that this was live feedback of their own heart rate. To manipulate controllability half the participants were taught a breathing exercise, and to manipulate labelling the source of arousal, half the participants were informed that their arousal level was due to headphone noise. The obese ate more when they were anxious and could not control or label the arousal. These participants only decreased intake when a label and a method of control were offered. Therefore, the findings suggest that, in obese participants at least, eating behaviours are especially susceptible to uncontrollable and diffuse stress. The results showed that control had more of an impact than labelling on eating. Therefore, this factor may be particularly important. The results of the Oliver et al. (2001) interpersonal stress study also suggest that lack of control may be an important factor, since the protagonists in the social stress procedure did not change their intake, only the target participants.

The type of stressor could interact with the participant's sex, since males are reported to be more physiologically reactive to achievement failure stressors and females to interpersonal stressors (Stroud et al., 2002), which could influence any conclusions about critical aspects of a stressor. There is also evidence that restrained eaters increase food intake following an active, rather than a passive, stressor (Lattimore & Caswell, 2004). Overall, the stress manipulation may impact on the relationship between stress and eating, whereby overeating is more likely to be induced by an active but uncontrollable stressor, involving a social or ego threatening component; though gender differences in response to different stressors could be further investigated.



### 1.5 Food Choice during Stress

The majority of stress-induced eating research has focused on the number of calories or the weight of food consumed in a meal or snack (e.g. Crowther et al., 2001; Herman & Mack, 1975). Other investigations have considered how other aspects of food intake could be affected by stress, including the taste and consistency of the chosen food and its macronutrient content (i.e. its proportion of carbohydrates, fats and proteins), and whether there is a change in snack or meal intake.

Self-report data indicate an association between stress and intake of high fat or carbohydrate rich foods. Participants in a study by Christiansen and Pettijohn (2001) reported that cravings for carbohydrates were preceded by feelings of anxiety and depression. Oliver and Wardle (1999) found that people reported eating more sweets and chocolates, cakes and biscuits and savoury snacks, but fewer portions of meat and fish or fruit and vegetables when stressed. These findings indicate a shift towards palatable or energy dense foods (i.e. those high in fat or sugar) when stressed. Self-labelled stress-eaters were found to eat a greater amount of sweet, salty and fatty foods (Laitinen et al., 2002).

Laboratory studies also show a preference for energy dense foods under stress, in response to a stress paradigm. Grunberg and Straub (1992) reported that men decreased consumption of sweet, bland and salty foods following a stressful film, while women ate more sweet food in the stressful condition. Oliver et al. (2000) measured intake from a multi-item test meal, following exposure to a presentation stressor task. The results showed that while intake was not changed across all participants, those high in emotional eating increased intake of sweet and fatty foods. Shapiro and Anderson (2005) found that restrained eaters consumed more crisps after an insoluble task even though they had not rated this food as the most palatable, a finding the authors attributed to a desire for energy rich food. The results of these three studies suggest that the intake of sweet or energy rich foods specifically increases with stress, but that this varies according to other known moderators of the stress-eating relationship.

Naturalistic studies have also suggested an increase in energy dense foods when stressed. Michaud et al. (1990) reported that students consumed a greater amount of



fat on the day of an exam, when anxiety was increased. In further support, Wardle et al. (2000) found that under high work stress, reported consumption of fat, saturated fat and sugar increased. In contrast to the above findings, Patel and Schlundt (2001) found no difference in the macronutrients consumed during a negative mood period compared with a neutral mood period, in obese participants. Overall, however, self-report data, naturalistic studies and laboratory research suggest that stress is associated with increased fat and carbohydrate consumption.

An alternative explanation for a stress-related change in food choice is that people increase their intake of snack foods, which tend to be highly palatable and rich in sugar and fat. It seems plausible that snacks would be particularly susceptible to stress-induced eating changes, since these foods are quick to prepare, widely available and thus very convenient. Oliver et al. (2000) further suggest that snacks are easier to digest than meals when in a state of physiological arousal associated with stress. Research addressing snack intake has tended to show an increased consumption during stressful periods. Nearly three quarters of the people in Oliver and Wardle's (1999) sample reported increased snacking when stressed. Daily measures studies have also found this change in snack and takeaway intake with stress and hassles (e.g. Conner et al., 1999; Steptoe et al., 1998). If this is the case, there are important implications for the introduction of available healthy snacks, as Oliver and Wardle (1999) have identified.

There are other aspects of food choice and intake pattern that warrant further investigation. Firstly, the visual appeal of foods eaten under stress could affect food choice when stressed. In an investigation of the food properties that affect consumption, Marcelino et al. (2001) found that visually appealing food stimulates appetite for that particular food. It may therefore be worth looking at how this affects choice of food when stressed, especially among high external eaters who are especially sensitive to these qualities. Food texture could also affect food choices when stressed. It has been reported that crunchy, rather than chewy foods are preferred under stress (Willenbring et al., 1986), a phenomenon that has been linked to nervous nail biting habits (Morley et al., 1986). This would coincide with the increased consumption of potato crisps reported by Shapiro and Anderson (2005),

although the foods chosen in the Oliver and Wardle (1999) and Oliver et al. (2000) studies were of varying textures.

Timing of meals and snacks could also be addressed. It may be expected that meals would be eaten late or in an irregular fashion due to time constraints when under stress. In support of this notion, Macht and Simons (2000) have reported that eating can be irregular when in a negative mood. However, Crowther et al.'s (2001) study of hassles and intake revealed no changes in meal pattern in association with daily hassles. Furthermore, an investigation of intake pattern could provide a timescale for the effect of stress on intake; however, more research is required before any conclusions may be made regarding this issue.

## **1.6 Mechanisms Underlying Stress-induced Eating**

The literature reviewed so far has addressed whether the general effects approach is an adequate model for stress-induced eating, and has highlighted a number of factors acting as important moderators of the relationship. The review will now turn towards the potential mechanisms underlying the stress-eating phenomenon, by considering first psychological then physiological theories.

### **1.6.1 Psychological Mechanisms**

The psychosomatic theory (Kaplan & Kaplan, 1957) was the first proposed mechanism for stress-induced eating in the obese, but was questioned due to findings that obese individuals often showed no change in food intake under stress (e.g. Schachter et al., 1968). This posed a problem for psychosomatic theory, which argued that obese individuals confuse arousal with hunger and therefore predicted an increase in consumption with stress. This led to the development of externality theory (Schachter et al., 1968) which could account for unchanged eating under stress, and was further supported by evidence of heightened sensitivity for external qualities of food (Decke, 1971). However, reports indicated that sensitivity to external food qualities is not increased under stress (e.g. Polivy et al., 1994), and that dietary restraint was a better predictor of stress-induced eating (Herman et al., 1978), leading to restraint theory (Herman & Polivy, 1975).



Restrained eating is not always the best predictor of stress-induced eating (Van Strien et al., 1986b) and restraint theory provides a more comprehensive explanation of increased intake following a preload rather than during stress. Later accounts of restrained eating concentrated less on the individual's set point, and the theory developed into the boundary model of restrained eating (Herman & Polivy, 1984). According to the boundary model, hunger and satiety sensations control the desire to engage and disengage in food intake. The area between these two boundaries is referred to as the 'zone of biological indifference', where social influences affect whether the individual eats, and where food consumption tends to occur before the hunger boundary is reached. In restrained eaters, it is theorised that a diet boundary is drawn within the zone of biological indifference and that the difference between the hunger and satiety boundaries is stretched as a result of continual dieting. Therefore it takes longer for the sensations of hunger and satiety to be perceived by the restrained individual. This means that when the diet boundary is violated by the preload, the individual can eat a large amount before the satiety boundary is reached. While disinhibition after breaking a diet may be understood in terms of satiety and hunger boundaries, this does not satisfactorily explain why individuals would begin eating under stress, since the diet boundary has not been crossed by a preload. Therefore, an explanation is required to bridge the gap between the moderator variables and the change in eating behaviour.

One possibility is that eating serves to comfort the distressed individual, as psychosomatic theory originally suggested. This would mean that anxiety is reduced either during or after food consumption. However, anxiety is not generally found to decrease following food consumption either in the laboratory or in naturalistic studies (e.g. Polivy et al., 1994; Polivy & Herman, 1999; Rutledge & Linden, 1998). In fact, increased eating only seems to increase negative feelings rather than relieve them (Solomon, 2001), and is associated with a delay in physiological recovery (Rutledge & Linden, 1998). Therefore there is little support for the comfort hypothesis.

A second explanation is based on the Theory of Learned Helplessness (Seligman, 1975), which describes the tendency for individuals to attribute events to external causes out of their own control, and to subsequently give up any attempts to achieve



related goals. To relate this theory to stress-induced eating, the individual's sense of loss of control under stress is generalised to other personal goals, including dietary restrictions, which are then resigned (Polivy & Herman, 1999; Rotenberg & Flood, 2000). This is an especially convincing theory for highly restrained eaters, for whom restricted food intake is an important personal goal, and in response to interpersonal or ego threatening stressors, which are likely to instil a sense of helplessness. There is evidence that restrained eaters are more likely to hold an external attribution style for food consumption, especially if they are female, and that these individuals are also more likely to disinhibit food intake after a preload (Rotenberg & Flood, 2000). To test the theory further, Rotenberg et al. (2005) examined the effect of primed control and lack of control cognitions on the eating behaviour of restrained eaters. The authors reported a greater food intake in restrained eaters after priming lack of control cognitions, which again suggests that feelings of helplessness or a loss of control play a role in disinhibited eating. Therefore it is possible that the activation of the external cognitions following the consumption of a preload cause the restrained eater to give up the diet.

However, the learned helplessness model receives less support when observing eating behaviour after an ego threatening stressor. Polivy and Herman (1999) found that highly restrained eaters who had disinhibited food intake after a failure stressor (insoluble anagrams) did report feeling that they may as well give up their diets, which does suggest a feeling of helplessness, but not that their goals in general were unachievable after the stressor. Feelings of helplessness regarding the diet may then contribute to the disinhibition effect in restrained eaters, but may be more applicable to the preload effect rather than stress-induced eating. It is also unable to account for stress-induced eating in other susceptible subgroups, like high emotional and external eaters, who are not necessarily trying to diet.

A third psychological explanation for stress-induced eating is that eating distracts the individual from the source of the distress, and serves as 'escape' from the source of distress. This may apply particularly to stressors that induce a strong sense of self-awareness, such as ego threatening stressors (Wallis & Hetherington, 2004), which drive the individual to escape from awareness of the stressor and the self, and redirect his or her attention to the immediate environment (Heatherton &

Baumeister, 1991). This shift in attention to the immediate and present means that there is a reduced awareness of ultimate, long-term goals, and the sense of relationship between current actions and future outcomes. With respect to eating behaviour specifically, this implies that restrictions about food intake and dieting for future weight loss are abandoned. This theory is supported by the findings that ego-threatening stressors have a particularly strong relationship with increased intake (Heatherton et al., 1991). Interestingly, a shift towards the immediate environment could also be used as an account for increased food intake in external eaters if food is present, since this population would be expected to eat in response to these food cues. Heatherton and Baumeister (1991) also point out that the shift in attention can explain the greater salience of external qualities of food in restrained eaters when stressed, as suggested by Slochower and Kaplan (1980).

There is evidence that individuals shift their attention away from stress-related stimuli after a stress manipulation (e.g. Ellenbogen et al., 2002), as escape theory would predict. It is unclear whether there is a shift towards environmental or food stimuli during stress. There are accounts of a general attentional bias for food stimuli in restrained eaters (e.g. Francis et al., 1997); however, no studies to date have examined a shift in attention when stressed, in either highly restrained or highly external eaters. Therefore, escape theory could be further tested by investigating attention or awareness for food and stress-related stimuli under conditions of high stress in subgroups susceptible to stress-induced eating.

Related to the theory of distraction is the ‘masking’ hypothesis (Herman & Polivy, 1988). Not only does the individual use eating as a distraction, but he or she also attributes the source of the distress to overeating rather than the stressor. In Herman and Polivy’s (1999) investigation participants did report eating to be the source of distress, lending support to the theory. This also accounts for the findings that anxiety would not be reduced by eating, only reattributed to an alternative source. However, it is possible that overeating is a genuine source of distress to dieters who are trying to restrict this behaviour, and so there may not be a redirection effect. While this hypothesis provides an interesting and complementary caveat to escape theory, it is not as yet well investigated.



A final theory for stress-induced eating is the cognitive demand or load theory, which proposes that a mentally demanding task, or the process of coping with a stressful task, poses too much of a cognitive load on individuals who are constantly preoccupied with thoughts and actions of maintaining a diet (Boon et al., 2002). Consequently the individual is unable to allocate full attention to the diet, and disinhibits food intake. As with escape theory, eating inhibitions are no longer monitored and consequently abandoned, though this is due to the demands of the task and an allocation of resources rather than a drive to escape from self-awareness. Because it is only dieters who are preoccupied with restricting food intake, this theory is applicable to restrained eaters rather than other susceptible subgroups. Therefore escape theory has the advantage over cognitive load as a more global account for stress-induced eating. However, in support of the cognitive demand theory, evidence does suggest that there are cognitive processing deficits in dieters and restrained eaters, which are not due to the metabolic effects of food deprivation (Herman et al., 1978; Jones & Rogers, 2003). There is also evidence that restrained eaters will consume a larger amount of food after a cognitively demanding task than a simple task, even if it is not stressful (Wallis & Hetherington, 2004). Similarly, Ward and Mann (2000) reported that restrained eaters consumed more food after a cognitive task where it was necessary to remember the presented stimuli (high cognitive load) than when memory would not be tested (low cognitive load). This means that it may not be stressfulness of the task that leads to food intake, but rather its cognitive demand that disrupts monitoring of the diet, in restrained eaters at least.

The cognitive demand theory also fits with the findings that active and not passive stressors are associated with increased food intake in restrained eaters (Lattimore & Caswell, 2004), since presumably passive stress demands less cognitive effort. However, this does not theoretically apply so easily to other eating subgroups, where cognitive resources would not need to be allocated to diet monitoring. In fact, Wallis and Hetherington (2004) reported that emotional eaters only increased food intake in response to an ego threatening stressor and not after the cognitively demanding task. There is also evidence that cognitive impairments in restrained eaters are more likely when food cognitions are primed before the task (Brunstrom & Witcomb, 2004), which implies that it may be oversimplistic to attribute the disinhibition effect solely to the demands of the task, and that individuals are not



always preoccupied by thoughts of food. Therefore cognitive demand theory only appears to hold for restrained eaters, for whom increased intake is less specific to stress, and may also require an inadvertent activation of food related cognitions. However, for restrained eaters, it may be argued that the cognitive load associated with processing or coping with stressful stimuli is sufficient to induce food intake rather than the need to escape self-awareness, and that escape theory is a smaller element of cognitive load.

Overall, the learned helplessness and comfort models of stress-induced eating have received little support. Escape theory and cognitive load both suggest that a reduction in inhibitions or self-monitoring is responsible for stress-induced eating, and are more convincing psychological mechanisms. It seems that for restrained eaters, any high demand cognitive task is enough to distract the individual from monitoring his or her diet. However, cognitive load theory is less convincing for other vulnerable subgroups, where attention and cognitions are not allocated to dieting or restricted intake. Escape theory also incorporates a shift in attention towards environmental stimuli, including food, and as such provides a more appealing account for stress-induced eating in external and emotional eaters.

### **1.6.2 Physiological Mechanisms**

Early reports of stress-induced eating in animals were attributed to the release of endogenous opiates during stress. It has been proposed that opiates are released during physiological stress for their analgesic effects, but that their release has an additional effect of stimulating food intake (Morley & Levine, 1980). In particular, the dynorphin opioid receptor is implicated in eliciting feeding behaviours (Levine et al., 1985). There is strong evidence that opiates are released during exposure to physical stress, supporting the first premise of this argument. Tail pinching is associated with a higher pain threshold, suggesting an analgesic effect of opiate release (Morley et al., 1986), and rats show typical opiate withdrawal behaviours, including bodyshakes, when naloxone, an opiate receptor antagonist, is administered after several days of repeated stress exposure (Morley & Levine, 1980). There is also evidence of increased opioid peptide levels in response to physical stressors in rodents (Teskey & Kavaliers, 1987). Such observations suggest that opiates are released during exposure to physical stressors.

Research has also shown that opiate release is associated with increased food intake (Billington et al., 1990; Fullerton et al., 1985), supporting the premise that opiate release induces feeding. Furthermore, stress-induced eating behaviours are inhibited by the administration of opiate receptor antagonists (Morley et al., 1986). These effects do not seem to be limited to unnatural stressors, such as the tail pinch paradigm. Social conflict has also been shown to activate opiate release and induce feeding in mice (Teskey et al., 1984); with both effects blocked by naloxone administration (Teskey & Kavaliers, 1987).

However, not all researchers have been able to replicate these findings. Antelman and Rowland (1981) did not find an inhibited stress-eating response with the administration of naloxone, or evidence of opiate withdrawal symptomology. Consequently, these researchers have argued that the decreased intake in other laboratories may be attributable to the pain of consuming gnawing food pellets during the pinch procedure, as a result of the naloxone administration inhibiting the analgesic effect of opiates. This may be a more valid criticism of the tail pinch paradigm than the defeat stressor tests, since tail pinches are less representative of natural situations, and it is unclear how well the eating response demonstrates a natural reaction. The criticism is also unable to explain why opioid administration increases food intake (Levine et al., 1985).

Opioids are not only related to analgesia, but also to the hedonic value of foods (see Yeomans & Gray, 2002 for a review). The opioid antagonists naloxone and naltrexone reduce preference ratings for palatable foods in humans (Drewnowski et al., 1992; Yeomans & Gray, 1997), while the partial opioid agonist butorphanol increases taste preference, in non-binge eaters at least (Drewnowski et al., 1992). Therefore it is perhaps not surprising that the release of opiates during painful stressors should be associated with food intake if the hedonic value of foods is increased, as Ferber and Cabanac (1987) have proposed. This argument is further supported by the findings that stress increases response rates for sucrose solution in rats, as is consistent with an increased value of a reward, and that this effect is reduced by the administration of naloxone (O'Hare et al., 2004). It is less clear if it is advantageous for opiates to increase food intake during stress. There is evidence that ingestion of sweet substances increases opiate production, and that, in turn,



stress-induced eating seems to cause increased consumption of sucrose (Fullerton et al., 1985). These phenomena suggest that opiates may be somehow involved in developing a preference for sweet foods during stress, which would then be beneficial energy repletion.

Overall there is evidence that stress-induced eating in animals is related to opiate release, although exactly how opiates affect eating is still fairly speculative. Whether the same physiological mechanism would apply in humans is unclear. It seems logical for opiates to be released during physical stressors for their analgesic effects, and even more naturalistic stress paradigms like social conflict involve a physical element. Whether opiates would be released in response to psychological stress is more doubtful, but it is apparent that the psychological characteristics of stress are significant in predicting eating response in humans (e.g. Slochower & Kaplan, 1980). In fact, it is already uncertain whether the opiate evidence even generalises to other rodents, such as guinea pigs (Billington et al., 1990). It is therefore a challenge for the opiate theory to explain the release of opiates without the presence of a painful stimulus in generalising the theory to stress-induced eating in humans.

An alternative physiological explanation revolves around the release of the neurotransmitter serotonin. Wurtman (1984) argues that individuals increase their food intake, particularly carbohydrates, when emotional, to increase serotonin production, and improve mood. This proposition is based on the known mechanisms of serotonin synthesis. Intake of carbohydrates increases levels of the serotonin precursor tryptophan relative to other amino acids, creating less competition for brain uptake of tryptophan (Ashley et al., 1985). Serotonin is then synthesised by a process of tryptophan hydroxylation (Fernstrom, 1987). The consumption of a high protein meal increases levels of other amino acids, and so produces the opposite effect (Ashley et al., 1985). Therefore carbohydrate consumption during stress is viewed as a form of self-medication. This theory is not without some support. One advantage is that it is able to account for an increase in carbohydrate cravings and intake during stress (e.g. Oliver & Wardle, 1999). There is also evidence of improved mood after carbohydrate consumption in certain subgroups, including obese individuals, high stress sufferers, and patients with



seasonal affective disorder (Lieberman et al., 1986; Markus et al., 2000; Rosenthal et al., 1989). There is also evidence of improved mood in non-clinical participants. Self-labelled carbohydrate cravers reported a change in mood, feeling relaxed and happy, after carbohydrate consumption (Christiansen & Pettijohn, 2001); and mood was found to improve after carbohydrate intake in healthy participants (Lloyd et al., 1996).

There are also a number of issues with the serotonin hypothesis. First of all it is debatable whether tryptophan levels rise sufficiently after carbohydrate consumption to enable a change in mood. Ashley et al. (1985) reported a small difference in tryptophan levels between participants who consumed a carbohydrate meal and those who consumed a high protein meal, but only in the morning. This would suggest that a sufficient change is dependent on the time of day of consumption. Even if there is a small rise in tryptophan after eating a meal or snack, it is unlikely to be enough to increase serotonin levels significantly to affect mood (Patel & Schlundt, 2001). In fact, evidence suggests that eating does not improve mood among normal populations, a point that was also a problem for psychosomatic and comfort theories (e.g. Rutledge & Linden, 1998). Therefore a change in mood after eating carbohydrate rich foods may only apply to clinical populations, as these effects are not seen in most individuals (Spring et al., 1987).

A further issue is whether people really do crave carbohydrates during periods of stress or depression as the serotonin hypothesis predicted. The increase in consumption of high carbohydrate foods could also be attributed to a craving for high fat foods, since high carbohydrate foods also tend to be high in fat (Drewnowski et al., 1992). Alternatively, people may just crave and subsequently gain pleasure and change in mood from foods that are highly palatable (Hill et al., 1991), since high carbohydrate and fat foods tend to be palatable (Le Magnen, 1987). In fact, many self-labelled carbohydrate cravers actually crave foods that tend to be high in both fat and carbohydrate (Drewnowski et al., 1992). Finally, the serotonin theory cannot explain differences between subgroups in terms of eating response, and does not offer an account of decreased intake in certain populations. While the serotonin hypothesis offers an appealing account of food choice under stress, there is little evidence that serotonin production is significantly increased or

that mood improves after its consumption in most people, leaving the central tenets of the theory unsupported.

A third physiological theory concerns the activation of the hypothalamic-pituitary-adrenal (HPA) axis, and the release of glucocorticoids. Activation of the hypothalamus as a result of stress or low glucocorticoid levels causes the hypothalamus to secrete corticotrophin releasing factor (CRF), stimulating the release of adrenocorticotrophic hormone (ACTH) from the pituitary. The release of ACTH acts in turn to stimulate the secretion of glucocorticoids, including cortisol, from the adrenal cortex, which then raise blood sugar levels by releasing fat from reserves. The HPA axis is theorised to form part of an energy balance system, whereby food intake is stimulated by glucocorticoids and decreased by the production of insulin (e.g. Dallman et al., 1994). There is also evidence that CRF may counteract the effects of glucocorticoids, acting as an anorectic (Friedman & Halaas, 1998; Laugero, 2001); although the effects of repeated exposure to CRF are less conclusive (Krahn et al., 1990). The energy balance model could explain the occurrence of stress-induced eating since glucocorticoids are released during stress, and in fact increased intake could be seen as an adaptive response to stress both in terms of increasing energy supplies and mobilising reserve stores.

A particular strength of this theory is that it may be able to account for individual differences in the stress-eating response, since individuals vary in HPA reactivity (Sapolsky, 1994; Smyth et al., 1997). In a direct test, Epel et al. (2001) investigated the differences in eating behaviour between high and low cortisol reactors on stressful and non-stressful laboratory sessions. Individuals who produced high levels of cortisol in response to stress ate more than low reactors, especially sweet high-fat food, in the stressful condition; but both high and low reactors ate a similar amount on control days. These findings suggest a strong link between cortisol production and increased food intake. Evidence has also found that appetite increases during the recovery phase of stress when cortisol levels are at their peak (Sapolsky, 1998), again suggesting a direct link between cortisol levels and intake.

Cortisol production is also linked to specific individual variables that moderate the stress-eating relationship. Firstly, there is evidence of a sex difference in cortisol response, so that females show cortisol elevations for a greater time period



following exposure to CRF than do males (Galluci et al., 1993). A sex difference in cortisol production could then relate to the greater incidence of increased intake in females when stressed. There is also evidence that males and females produce different cortisol responses according to the type of stressor, where a social rejection paradigm produces a response in females and a mathematical challenge is associated with an increased output in males (Stroud et al., 2000). It could be the case that males and females would also show different eating behaviours with stressor type depending on the related change in cortisol. Secondly, there is evidence that dietary restraint is related to cortisol production. Highly restrained eaters have shown greater levels of both urinary and salivary cortisol than unrestrained eaters (McLean et al., 2001; Anderson et al., 2002), which may be due to the stressfulness of constantly monitoring food intake. This difference in cortisol secretion could be related to the differences in stress-eating behaviour between restrained and unrestrained individuals, and it is worth testing whether the groups also differ in cortisol response to stress.

The link between glucocorticoids and increased food intake could also go some way to explaining the moderating role of obesity. Theoretically, eating during stress could encourage the development of central obesity. Glucocorticoids stimulate the release of insulin, which in turn inhibits feeding (Bjorntorp & Rosmond, 2000); but eating at a time when insulin is high promotes the storage of this energy, and in particular in the central areas, where glucocorticoid receptors are dense (Bjorntorp, 2001). In the long term, the production of glucocorticoids could also lead to the development of leptin insensitivity meaning that satiety is not signalled to the individual and hence eating is not cessated at the appropriate time (Bjorntorp & Rosmond, 2000). It is therefore possible that stress-induced eating leads to obesity rather than vice versa.

The role of cortisol in stress-induced eating can be further validated by investigating its effects on food choice. In animals, the release of glucocorticoids with stress was associated with increased consumption of palatable food, and furthermore, HPA activity was reduced after palatable food intake (Pecoraro et al., 2004). An effect of cortisol on food choice can also be observed in humans. Tataranni et al. (1996) administered glucocorticoids to participants in the laboratory and monitored ad

libitum food intake. Those in the experimental condition receiving glucocorticoids increased their intake of both carbohydrates and protein. This corresponds with the previous findings of increased carbohydrate intake when stressed (e.g. Wardle et al., 2000), though not reports of increased fat (e.g. Michaud et al., 1990). It has been proposed that eating high sugar and carbohydrate foods after stress is an adaptive behaviour, since it promotes energy storage for future encounters, and the reward value of such highly palatable foods serves to reinforce this adaptive response (Laugero, 2001). Therefore it may make biological sense for cortisol production to promote intake of high-energy foods. Similarly, a cortisol based account would match with evidence of increased intake in response to uncontrollable stressors (e.g. Slochower et al., 1981), since cortisol secretion is greater following an uncontrollable stressor manipulation (Markus et al., 2000).

Therefore the role of cortisol in stress-induced eating is a promising area of research and the exact mechanisms of its relationship with eating under stress need to be further investigated. The effects of glucocorticoids on food intake are not necessarily direct, as they are shown to increase production of Neuropeptide Y, a compound already known to increase intake (Strack et al., 1995; Sainsbury et al., 1997) and inhibit the actions of leptin, a known energy regulation hormone (Zakrzewska et al., 1997). These compounds could therefore mediate any stress-eating role of cortisol and other glucocorticoids.

Overall, the opioid theory is well-supported for tail pinch stressors in animals, but seems less convincing as an account of eating in response to psychological stressors in humans. The serotonin hypothesis provides an explanation for food choice under stress, but lacks empirical support concerning a substantial rise in serotonin production with food intake. The glucocorticoid theory provides a comprehensive account in humans and animals and may account for the effects of psychological stressors; however, the mechanism has not been fully investigated.

### **1.7 Shortcomings in the Literature**

The stress-induced eating literature now recognises the importance of individual differences in the direction of effects, and has adopted an individual differences rather than a general effects approach to its study. In this process, a number of important moderating factors have been identified. However, many of these



variables are highly correlated with one another, and research has not yet formulated a comprehensive model of the relationship between different moderator variables and how these interact to affect food intake. The role of personality variables has also been relatively neglected. Therefore the first shortcoming with the stress-induced literature so far are the lack of a direct test of the combined effects of moderator variables, and the want of a theoretical model on which to base such an investigation.

A second shortcoming of the literature concerns the mechanisms underlying stress-induced eating. While many studies have considered the moderators of the stress-eating relationship, fewer studies have investigated its underlying mechanisms, which are also crucial for health interventions. Research supports the role of both psychological and physiological accounts, and it seems implausible that a full account would not incorporate the two approaches, since stress by itself involves a situational appraisal as well as a physiological response. As yet, research has not addressed how moderator variables, physiological activity and psychological characteristics of the stressor relate with each other to explain stress-induced eating.

On a practical level, the research so far shows a number of limitations. While animal studies may be informative about physiological mechanisms of stress-induced eating, it is difficult to liken the stress manipulations of most animal paradigms to human situations, which would be expected to be far more psychological in nature. However, even in human research there has been a high dependence on laboratory based stress manipulations, particularly in the restrained eating studies. Therefore the stress manipulations are questionable in their representation of the stressors faced in real life. Theory and early research suggest that the effect on eating may be dependent on the characteristics of the stressor, but the direct effect of different types of stress, particularly in the field, has not been conducted. Finally, very little research has investigated the pattern of intake or the time delay between exposure to the stressor and food intake, which may be particularly relevant to mapping of biological activity.

## **1.8 Conclusions**

Altogether, it is clear that the effect of stress on eating is not uniform, with increased, decreased or no change in intake reported in humans. Accordingly, it is

more appropriate to study stress-induced eating with reference to individual differences. Bodyweight, gender and eating style are strong predictors of intake, such that increased intake is expected in females who are obese and score highly in restrained, emotional or external eating style; though emerging research also suggests a role for conscientiousness and perfectionism. It is apparent that food choices are affected by stress, with a shift towards high energy and snack foods. Much research still needs to be conducted to understand the underlying mechanism for stress-induced eating. So far evidence points towards an integration of psychological and biological theory, with encouraging developments in the form of escape theory, cognitive load and glucocorticoid control of appetite. Future research is required to test the effect of stress outside the laboratory, although this research is growing, and to further assess the effect of different types of stress on eating response. Finally, there is a need to develop a comprehensive model of the relationship between stress, moderator variables and eating response, and to test further the underlying mechanisms, in formulating interventions aimed at promoting healthy eating behaviours during stress.

## **1.9 Aims and Overview of the Thesis**

### **1.9.1 Thesis Aims**

The overall aim of the thesis was to gain a greater understanding of the moderators and mechanisms of stress-induced eating, with a particular focus on increased food intake. The first aim of the thesis was to examine the moderators of stress-induced eating and the relationships between these moderator variables, focusing on gender, bodyweight, eating style and personality. The second aim was to investigate more fully the relationship between the types of stressors experienced, and types of food consumed. The third aim of the thesis was to explore the underlying mechanisms of stress-induced eating, considering both physiological and cognitive accounts, by investigating the attentional processing of food stimuli under stress and individual differences in cortisol reactivity to stress. In pursuing these main aims, the thesis employed a range of research methodologies, complementing laboratory investigation with naturalistic and survey data collection.



### 1.9.2 Thesis Overview

Chapters Two, Three and Four of the thesis report on the empirical studies conducted. Chapter Two concentrates on the moderators of stress-induced eating, and the relationship between stressor characteristics and foods consumed. The chapter reports on the findings from two survey studies (Studies One and Two). Study One collected questionnaire data from a large sample, asking respondents to record perceptions of intake under stress, as well as specific stressors experienced and snacks consumed the previous day. Study Two employed a diary methodology, with participants recording their daily mood, hassles and snack intake over a period of fourteen days.

Chapter Three focuses on an attentional processing mechanism for stress-induced eating, and investigates biases for food stimuli under control and stress conditions in external eaters. Three studies are reported in this chapter (Studies Three, Four and Five). Study Three tested attentional biases for food words in response to a laboratory stressor in high and low external eaters, using a computerised modified Stroop and dot probe as measures of attentional bias. Study Four measured attentional biases for food words in response to a laboratory stressor on a dot probe task, with word exposure times varying between trials. Study Five study replicated the procedure of Study Four, but varied the exposure time of food pictures instead of words.

Chapter Four continues from Chapter Three in examining underlying mechanisms for stress-induced eating. This chapter explores whether differences in cortisol reactivity underlie stress-induced eating, and reports an investigation of eating in pre-menopausal women (Study Six). Study Six measured salivary cortisol reactivity to a laboratory stress procedure, comparing the laboratory food intake of high and low cortisol reactors. The study also examined whether high and low reactor groups differed in their eating response to everyday stress, through diary records of hassles and food intake over fourteen days. The final chapter of the thesis, Chapter Five, provides a general discussion of the findings from the six studies reported in the preceding chapters. This chapter draws conclusions from the findings of these six studies with respect to the moderators and underlying mechanisms of stress-induced eating, and considers directions for future research.

## CHAPTER TWO

# INVESTIGATING THE MODERATORS OF STRESS-INDUCED EATING

### 2.1 Introduction

Chapter One highlighted that the effect of stress on eating behaviour is not uniform across individuals. Laboratory manipulations of stress and self-report data both show that some individuals eat more in response to stress, while others eat less or the same amount (e.g. Cools et al., 1992; Oliver & Wardle, 1999). As a consequence, testing the effect of stress on eating behaviour across a group of individuals means that effects within individuals could be masked. A more comprehensive model of stress-induced eating therefore needs to take into account the factors that predict the direction of the effect. Such factors are likely to include individual differences variables serving as moderators, the type of stress experienced, and the type of food consumed.

The majority of human stress-induced eating research has been dedicated to discerning individual moderator variables. Females are purportedly more likely to increase food intake when stressed (e.g. Grunberg & Straub, 1992), as are obese individuals (e.g. McKenna, 1972) and dieters (Herman & Mack, 1975). Eating style has also been shown to strongly predict stress-induced food intake. In particular, dietary restraint has been highlighted, with highly restrained individuals more likely to increase food intake than unrestrained individuals (e.g. Herman & Polivy, 1975; Wardle et al., 2000); though it has been argued that tendency towards disinhibition is the key variable, mediating the moderation effect of restraint (Westenhoefer et al., 1994). In this respect, restrained eaters differ from dieters per se, as not all dieters are susceptible to disinhibition (Lowe, 1995). External and emotional eating styles are additional moderators of stress-induced eating. Derived from the psychosomatic and externality accounts of obesity (Kaplan & Kaplan, 1957; Schachter et al., 1968), emotional eaters were predicted to increase intake under stress and external eaters to eat in any situation where food cues were present. Emotional eating has been shown to moderate stress-induced eating, such that high, but not low, emotional eaters increase intake under stress (Oliver et al., 2000; Van Strien et al., 2000). External



eating has been associated with both stress and binge eating disorder (Pinaquy et al., 2003) and found to moderate the relationship between daily hassles and snack intake, whereby external eaters are more likely to increase food intake (Conner et al., 1999). However, few studies have directly tested the moderating roles of emotional and external eating styles, and these variables have been neglected relative to dietary restraint.

The moderating role of personality has also been sparingly researched. Early studies reported that those susceptible to increased food intake are more reactive to stressful conditions (Abramson & Wunderlich, 1972; Polivy et al., 1978). Therefore neuroticism, a lack of emotional stability, might be expected to influence the stress-eating relationship, since highly neurotic individuals would be expected to react more strongly to stressful situations than stable individuals. However the role of neuroticism in moderating stress-induced eating has not yet been investigated. Perfectionism could also be expected to moderate stress-induced eating. Perfectionism tends to be high in restrained individuals (Slade & Dewey, 1986), and it has been theorised that restrained perfectionists perceive breaking diet boundaries as a greater failure than do non-perfectionists, increasing the likelihood of overeating (Ruderman, 1985). Consequently, disinhibited eating could be more prevalent in perfectionists, especially those who are also restrained eaters.

Recently the role of conscientiousness in stress-induced eating has been implicated. Low conscientious individuals also dieting or high in self-oriented perfectionism were reported to increase snack intake during a stressful period (O'Connor & O'Connor, 2004). This finding makes intuitive sense, since highly conscientious individuals would be expected to preserve health behaviours to a greater degree than those low in this trait (Friedman et al., 1995). Conscientiousness scores also tend to be lower in external and emotional eaters (Heaven et al., 2001), suggesting that conscientiousness could mediate effects of eating style, or show a moderating effect through association with eating style variables. Despite indications that personality variables may serve to moderate the stress-eating relationship, so far no studies have reported on the role of all the 'Big Five' personality constructs in predicting the effect of stress on food intake.

While eating style, bodyweight, gender and possibly personality have been identified as moderators of the effect of stress on eating behaviour, few studies have investigated the simultaneous moderating roles of these variables. This is problematic for developing a comprehensive account of the stress-induced eating, as it is difficult to assess the relative contribution of individual moderators. This is particularly the case for laboratory-based research. In contrast, a number of field studies have explored the role of a variety of moderators (e.g. Conner et al., 1999; Steptoe et al., 1998), though they have not shown consistent findings in the relative importance of moderating variables.

The relationship between stress and eating may also be dependent on the type or characteristics of the stressor. Uncontrollable, ego threatening and interpersonal stressors are particularly associated with increased food intake (Heatherton et al. 1991; Slochower et al., 1981; Tanofsky-Kraff et al., 2000). These findings suggest that the psychological characteristics of a stressor are important in determining eating response, meaning that certain stressors are more likely to induce an eating response, and that physical stress would be less associated with any change in eating behaviour. In fact, physical stressors have been associated with a hypophagic response (Heatherton et al., 1991). The effect of the stressor characteristics has been investigated to an extent within the laboratory; but so far field studies, such as diary records of hassles and food intake, have not researched this aspect of stress-induced eating.

A further moderator of stress-induced eating concerns the type of food consumed during stress. Certain types of food do appear to be preferred during stress, according to their taste, nutritional content, texture and accessibility. Evidence has shown a preference for sweet foods, especially in women (Grunberg & Straub, 1992; Oliver & Wardle, 1999), which may be attributable to carbohydrate cravings (Wurtman, 1984). There are also findings of preferences for crunchy foods (Willenbring et al., 1986) and high fat foods (Wardle et al., 2000) during stress. The relationship between stress and eating might also hold more strongly for snack foods than meals (Conner et al., 1999), due to their high accessibility. These reports suggest that stress has subtle effects on food intake according to all these characteristics, thus highlighting the importance of assessing intake of different



types of food in response to stress (e.g. O'Connor & O'Connor, 2004; Oliver & Wardle, 1999; Steptoe et al., 1998).

Eating response to stress can be gauged in a number of ways, such as ascertaining people's perceptions of the effects of stress (e.g. Oliver & Wardle, 1999), measuring food intake in response to a laboratory stressor (e.g. Herman and Polivy, 1975) or through diary records of hassles and food intake (e.g. Conner et al., 1999). An advantage of asking people for their perceptions of intake under stress is that they are likely to consider their response to daily or real-life stressors. Similarly, diary records should represent real-life stressors, giving both these methodologies an advantage over laboratory paradigms. Diary data provide a record of actual stressors and food eaten, whereas people's perceptions may not reflect their actual eating behaviour; however, diaries are more arduous for participants to complete, lending advantages and disadvantages to both methodologies.

At present there is no complete account of stress-induced eating, with respect to all known moderator variables, stressor characteristics and food choice. This chapter addresses this issue by posing three main research questions. First, what are the most important moderators of stress-induced eating and how do these relate to each other? Second, are certain types of stress more strongly associated with stress-induced eating than others, and if so, what stressor characteristics can predict this relationship? Third, what types of food are consumed in response to stress, and how can these be understood in terms of nutrition and sensory quality?

## **2.2 Study One: Stress and food choice in students**

Study One investigated stress-induced eating in a student population through a large cross-sectional survey. The aims of this first study were to investigate students' perceptions of the effect of stress on food intake, and the relationship between the daily hassles encountered and snack intake on the previous day to completing the questionnaire. Therefore the study focused on both perceived and specific effects of stress on eating behaviour. There was a particular focus on the effect of stress on snack intake, since snack intake may be more susceptible to change than the amount eaten at meals. Gender, bodyweight, eating style and emotional stability were measured as potential moderators of a stress-eating relationship.

### 2.2.1 Method

#### *Participants*

Three hundred and fifteen students completed a brief questionnaire, titled 'Eating Questionnaire'. The sample included 102 males and 213 females. The average age of the sample was 20.59 years (SD=3.22) and the average body mass index was 21.94 (SD=2.79). Forty participants within the sample reported that they were currently on a diet<sup>1</sup>.

#### *Procedure*

The participants were selected using a convenience sampling method. The participants were approached to complete the questionnaire either during an allocated time in a lecture, or in seated areas across the University of Leeds campus. The questionnaire took approximately ten minutes to complete (please refer to Appendix 2.1 for questionnaire and Appendix 2.2 for ethics approval).

#### *Measures*

Demographic data was obtained from participants by asking at the start of the questionnaire for age, gender, height and weight. Dieting status was assessed by the written question, 'Are you currently on a diet?' with yes and no response options. Eating style was measured using the Dutch Eating Behaviour Questionnaire (DEBQ; Van Strien et al., 1986a). This 33-item questionnaire includes scales for external eating (10 items, e.g. 'If you see others eating, do you also have a desire to eat?'), emotional eating (13 items, e.g. 'Do you have a desire to eat when you are upset?') and restrained eating (10 items, e.g. 'Do you deliberately eat foods that are slimming?'). This scale has been validated and shown to possess good reliability within a British sample by Wardle (1987). The DEBQ scales all showed good internal reliability in the present sample (Cronbach's alphas = 0.95, 0.92 and 0.84 for restrained, emotional and external eating respectively). Tendency to disinhibit food intake was assessed using the Disinhibition Scale of the Three Factor Eating Questionnaire (TFEQ; Stunkard & Messick, 1985). This sixteen-item scale contains items such as, 'Sometimes when I start eating, I just can't seem to stop'. The

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<sup>1</sup> No distinction was made between dieting for weight loss and weight maintenance



reliability of the TFEQ has been previously validated by Stunkard and Messick (1985). The internal reliability in the current sample was satisfactory ( $\alpha=0.71$ ; Nunally, 1978). The participants also completed a shortened 10-item Emotional Stability scale from the International Personality Item Pool (IPIP; Goldberg, 1999). For this scale, respondents were asked to rate the accuracy of the ten statements for themselves, on a five-point scale from 'very inaccurate' to 'very accurate'. This scale has been validated by Goldberg (1999) and contains items such as 'I get upset easily'. In the current sample, emotional stability showed good internal consistency (Cronbach's  $\alpha=0.89$ ).

Measures of stress-related overall food and snack intake were obtained by asking participants to rate on a five-point scale how their intake differed from usual under stress. Specifically, participants were prompted to complete the sentences, 'When you are stressed, would you say that your food intake is...' and 'When you are stressed, would you say that your intake of snacks is...' with the response options 'much more than usual', 'more than usual', 'the same as usual', 'less than usual' and 'much less than usual' (based on Oliver & Wardle, 1999). The questionnaire also directly investigated the effect of stress on eating, by asking participants to rate the level of stress experienced the day previously, on a seven point anchored Likert scale from 'not at all stressed' to 'extremely stressed'. The participants were prompted to report specific stressors or hassles that they had encountered the day before. Respondents were asked to report each stressor in a box (the questionnaire provided five boxes) and report how intense each was by circling a number on a five-point scale from 'not at all' to 'very much'. Finally, respondents were prompted to list all snacks consumed on the previous day (snacks were defined as foods eaten between meals) within the five boxes provided.

### ***Statistical analysis***

Chi-squared analyses were conducted to examine the differences between males and females, and dieters and non-dieters in perceptions of eating behaviour changes under stress, following the procedure of Oliver and Wardle (1999). The relationships between eating style and perceptions of changes in overall and snack intake were assessed using Pearson's Product-Moment Correlations and multiple regression analysis. Specific effects of stress on eating were tested by conducting

Pearson's correlations between the level of stress reported on the previous day and the number of snacks consumed. Snack foods were also categorised into different food types and correlations were conducted between the stress levels and number of each type of snack consumed. Forced entry multiple regression was conducted to investigate the predictive power of stress, gender and eating style for the number of each type of snack consumed. Multiple regression was chosen as the appropriate method of analysis because it controls for shared variance between individual predictors, and interaction terms could be created to test moderating effects of eating style variables within the large sample (see Baron & Kenny, 1986). Furthermore, a forced entry method was chosen because certain predictors were not theorised to be more important than others. Reported hassles were coded into different stressor types and Pearson's correlation coefficients calculated between the presence of each hassle type and the number of snacks consumed.

## 2.2.2 Results

### 2.2.2.1 Descriptive statistics

#### *Correlations between diet, gender and eating style*

Pearson's product-moment correlation coefficients were calculated between eating style, diet status and gender, and are shown in Table 2.1. The eating style measures were highly positively inter-correlated. External eating score correlated significantly and positively with emotional eating and disinhibition (both  $p < 0.01$ ). Emotional eating score also correlated significantly with dietary restraint and disinhibition (both  $p < 0.01$ ), and restraint and disinhibition were correlated with each other ( $p < 0.01$ ).

Gender correlated with diet status ( $p < 0.01$ ), indicating that more females than males were dieting (18.3% of females, 2.6% of the males). Gender also correlated with emotional eating, restraint and disinhibition ( $p < 0.01$ ). Independent t-tests showed significant differences in restraint ( $t(313) = -10.59$ ,  $p < 0.001$ ), emotional eating ( $t(313) = -7.46$ ,  $p < 0.001$ ) and disinhibition ( $t(312) = -5.61$ ,  $p < 0.001$ ), where females had greater scores. Diet status correlated significantly with emotional eating score, restraint, disinhibition (all  $p < 0.01$ ) and BMI ( $p < 0.05$ ), indicating that those currently on a diet scored more highly on these eating style variables and had larger BMIs.



Table 2.1 Correlation coefficients between all eating style, stress and intake measures (N=315)

|                      | <i>Gender</i> | <i>Diet</i> | <i>BMI</i> | <i>Restrain</i> | <i>External</i> | <i>Emotion</i> | <i>Disin</i> | <i>Emot</i> | <i>Stress</i> | <i>Hassle</i> | <i>Intake</i> | <i>Snack</i>  | <i>No.</i>    |
|----------------------|---------------|-------------|------------|-----------------|-----------------|----------------|--------------|-------------|---------------|---------------|---------------|---------------|---------------|
|                      |               |             |            |                 |                 |                |              | <i>stab</i> | <i>level</i>  | <i>intens</i> | <i>rating</i> | <i>rating</i> | <i>snacks</i> |
| <i>Gender</i>        | -             | -0.25**     | -0.25**    | 0.48**          | 0.11            | 0.41**         | 0.30**       | -0.34**     | 0.09          | 0.002         | 0.21**        | 0.15**        | 0.11          |
| <i>Diet</i>          |               | -           | -0.13*     | -0.44**         | -0.07           | -0.18**        | -0.27**      | 0.08        | -0.12*        | -0.05         | -0.11         | -0.10         | 0.03          |
| <i>BMI</i>           |               |             | -          | 0.10            | -0.04           | -0.05          | 0.20**       | 0.11        | 0.07          | 0.10          | 0.11          | 0.09          | -0.10         |
| <i>Restrain</i>      |               |             |            | -               | 0.07            | 0.40**         | 0.48**       | -0.18**     | 0.14*         | 0.08          | 0.11*         | 0.10          | -0.09         |
| <i>External</i>      |               |             |            |                 | -               | 0.41**         | 0.42**       | 0.07        | 0.05          | 0.05          | 0.08          | 0.16**        | 0.14*         |
| <i>Emotion</i>       |               |             |            |                 |                 | -              | 0.66**       | -0.31**     | 0.19**        | 0.10          | 0.46**        | 0.48**        | 0.12*         |
| <i>Disinhib</i>      |               |             |            |                 |                 |                | -            | -0.23**     | 0.21**        | 0.14*         | 0.33**        | 0.36**        | 0.03          |
| <i>Emot stab</i>     |               |             |            |                 |                 |                |              | -           | -0.34**       | -0.18**       | -0.06         | -0.08         | -0.02         |
| <i>Stress</i>        |               |             |            |                 |                 |                |              |             | -             | 0.54**        | 0.07          | 0.11*         | 0.02          |
| <i>Hassle intens</i> |               |             |            |                 |                 |                |              |             |               | -             | 0.001         | 0.06          | 0.06          |
| <i>Intake rating</i> |               |             |            |                 |                 |                |              |             |               |               | -             | 0.68**        | 0.07          |
| <i>Snack rating</i>  |               |             |            |                 |                 |                |              |             |               |               |               | -             | 0.03          |
| <i>No. snacks</i>    |               |             |            |                 |                 |                |              |             |               |               |               |               | -             |

\* Correlation is significant at p<0.05 level

\*\* Correlation is significant at p<0.01 level

### 2.2.2.2 Perceived effects of Stress on Eating

The questionnaire respondents showed individual differences in the perceived effects of stress on both overall intake and snack intake. Table 2.2 shows the percentages for each intake response, for both overall intake and snack intake.

**Table 2.2 Perceptions of overall and snack intake under stress (N=315)**

| <i>Intake response</i> | <i>Overall intake (%)</i> | <i>Snack intake (%)</i> |
|------------------------|---------------------------|-------------------------|
| Much less than usual   | 4.4                       | 1.9                     |
| Less than usual        | 17.5                      | 10.8                    |
| The same as usual      | 27.0                      | 20.6                    |
| More than usual        | 42.5                      | 49.5                    |
| Much more than usual   | 8.3                       | 16.8                    |

Table 2.2 shows that sample varied in perceptions of stress on food and snack intake, with some individuals reporting eating less and others eating more under stress. The majority of the respondents perceived that they ate more than usual when stressed, in terms of both overall and snack intake. For overall intake, 42.5% felt that they ate more than usual and a further 8.3% reported eating much more than usual. This pattern was even more apparent for snack intake, where 49.5% respondents felt that they ate more than usual and 16.8% much more than usual. In the case of snack intake, approximately two thirds of the sample reported an increased intake in response to stress.

### *Gender differences in perceptions*

To test for gender differences in perceived food and snack intake when stressed, the 'much less' and 'less' responses were combined, as were the 'much more' and 'more' responses (based on procedure of Oliver & Wardle, 1999). This provided categories of 'hypophagic' response to stress (i.e. reported eating less) and 'hyperphagic' response to stress (i.e. reported eating more). For overall intake, women were more likely to report a hyperphagic response to stress. 63.7% of women reported that they were hyperphagic, compared with 24.5% men. The males in the sample were also more likely to report no change in eating behaviour with stress than were females: 54.9% of males perceived that there was no change,



compared with 13.7% of females. In terms of decreased intake, male and female's perceptions were very similar, with 20.6% females and 22.6% males reporting a decrease in intake with stress. Chi squared test showed that there was a significant gender difference in perceived effects of stress on overall intake ( $\chi^2 (2) = 64.10$ ,  $p < 0.001$ ), reflecting the greater hyperphagic reports in females, and the high reports of no change in intake in males. For snack intake, females were also more likely than males to report a hyperphagic response, with 75% of females reporting increased intake, compared with 49% of males. Males were more likely than females to report eating the same amount as usual under stress, with 44.1% of males reporting no change compared with 9.4% of females. A Chi squared test again showed a significant difference between males and females ( $\chi^2 (2) = 51.10$ ,  $p < 0.001$ ), highlighting greater perceptions of increased intake in females, and perceptions of no change to snack intake in males.

#### ***Diet status differences in perceptions***

The same procedure was used to test a difference in perceived eating responses between dieters and non-dieters in overall intake and snack intake perceptions, classifying responses as hyperphagic, no change or hypophagic. There was a slightly greater tendency towards a hyperphagic stress response in overall intake in dieters compared with non-dieters, with 67.5% dieters reporting increased intake compared with 49.2% non-dieters. However, Chi squared found no significant difference in perceptions between the dieting and non-dieting groups ( $\chi^2 (2) = 5.13$ , n.s.). Perceived effects of stress on snack intake were more similar between dieters and non-dieters, with a very slightly greater percentage of hyperphagic responses in the dieter group: 77.5% of the dieters reported increased snack consumption with stress compared with 65% of non-dieters. Chi squared showed no significant differences in snack perceptions between the diet status groups ( $\chi^2 (2) = 3.35$ , n.s.).

#### ***Correlations between eating style, emotional stability and perceived effects of stress***

Table 2.1 shows the Pearson's Product-Moment Correlation Coefficients between eating style and emotional stability and the perceived effects of stress on overall and snack intake. Perceived overall intake was significantly related to emotional eating, and disinhibition (both  $p < 0.01$ ), and restrained eating ( $p < 0.05$ ). The positive coefficients indicated that increasing scores on all three eating style measures were

associated with increases in perceived food intake under stress. Perceived change in snack intake also correlated significantly with emotional eating, disinhibition and external eating (all  $p < 0.01$ ). As score increased on all three eating measures, so did perceived snack intake under stress. Emotional stability score was unrelated to perceptions of intake during stress, but was significantly negatively related to disinhibition, restraint and emotional eating (all  $p < 0.01$ ), indicating lower levels of stability as these eating style measures increased.

***Regression analysis of the relationship between eating style, emotional stability and perceived effects of stress on intake***

The predictive power of the eating style variables for overall intake was investigated using multiple regression analysis. The variables of body mass index, external, emotional and restrained eating style, disinhibition and emotional stability were entered simultaneously. Table 2.3 shows the beta coefficients for each predictor variable for both overall food intake and snack intake.

**Table 2.3 Eating style regression coefficients for perceived intake (N=315)**

| <b>Predictors</b>    | <b><i>Overall intake</i></b> |           |               | <b><i>Snack intake</i></b> |           |               |
|----------------------|------------------------------|-----------|---------------|----------------------------|-----------|---------------|
|                      | <b>B</b>                     | <b>SE</b> | <b>Beta</b>   | <b>B</b>                   | <b>SE</b> | <b>Beta</b>   |
| BMI                  | 0.02                         | 0.02      | 0.06          | 0.02                       | 0.02      | 0.05          |
| External eating      | -0.03                        | 0.01      | -0.15*        | -0.01                      | 0.01      | -0.08         |
| Emotional eating     | 0.06                         | 0.01      | 0.52**        | 0.05                       | 0.01      | 0.47**        |
| Restraint            | -0.01                        | 0.01      | -0.11         | -0.01                      | 0.01      | -0.12         |
| Disinhibition        | 0.04                         | 0.03      | 0.11          | 0.04                       | 0.03      | 0.13          |
| Emotional stability  | -0.01                        | 0.01      | -0.10         | -0.01                      | 0.01      | -0.05         |
| <b>R<sup>2</sup></b> |                              |           | <b>0.25**</b> |                            |           | <b>0.24**</b> |

\*  $p < 0.05$

\*\*  $p < 0.01$

The regression model significantly predicted perceptions of changes in overall intake ( $F(6,280) = 15.30$ ,  $p < 0.01$ ), accounting for 25% of the variance. Table 2.3 shows that the significant predictors were emotional eating ( $p < 0.01$ ) and external eating ( $p < 0.05$ ), where increasing levels of emotional eating and decreasing levels of external eating were associated with perceptions of increasing overall intake under stress. The model also significantly predicted perceived change in snack intake



( $F(6,280)=14.74$ ,  $p<0.01$ ), accounting for 24% of the variance. The only significant predictor was emotional eating score ( $p<0.01$ ), showing that as emotional eating score increased, so did perceptions of increased snack consumption under stress.

### **2.2.2.3 The effect of stress on intake of specific snacks**

#### ***Correlations between stress levels and specific snacks on previous day***

The number of reported snacks consumed during the previous day ranged from zero to six, with a mean number of 1.77 snacks. The level of stress experienced during the previous day ranged from one to seven on the seven-point scale, with a mean rating of 3.24. Table 2.1 showed that the relationship between reported level of stress and number of snacks consumed on the previous day was non-significant. The number of reported snacks was also unrelated to either the total number of hassles or the total intensity ratings of the hassles (both n.s.).

The reported snacks were categorised according whether they were healthy, unhealthy, savoury or sweet or high in fat, using the nutritional values provided in McCance and Widdowson's (1978) Composition of Foods. The median fat content value was used to assign snacks to high and low fat groups, and median sugar value was used to assign snacks to savoury and sweet categories. The snacks were classified as unhealthy if high in fat or sugar, and as healthy if low in fat and sugar. Pearson's Product-Moment Correlations showed no significant relationships between stress levels the previous day and the number of healthy snacks ( $r=-0.06$ , n.s.), unhealthy snacks ( $r=0.08$ , n.s.), savoury snacks ( $r=0.05$ , n.s.), sweet snacks ( $r=-0.03$ , n.s.) or high fat snacks consumed ( $r=0.06$ , n.s.). In female respondents there was a positive relationship between stress the day previously and the number of unhealthy snacks consumed ( $r=0.17$ ,  $p<0.05$ ). However, this relationship was not significant in males ( $r=-0.09$ , n.s.).

#### ***Multiple regression analysis of the relationship between stress levels and composition of snacks***

Forced entry multiple regression analysis was conducted to test the predictive power of stress levels the previous day, eating style and emotional stability on the numbers of snacks consumed. Stress level, eating style and emotional stability were entered

in the first block of regression variables. Interaction terms were created for stress rating with disinhibition, external eating, emotional eating, dietary restraint and emotional stability and entered into the second block of regression, to test for moderation effects of eating style and emotional stability (method of Baron & Kenny, 1986). Table 2.4 shows the coefficients of the predictor variables entered in the first and second blocks of the regression model, in predicting the total number of snacks consumed.

**Table 2.4 Effects of moderator variables on the number of snacks consumed with the first and second blocks of regression (N=315)**

| <i>Moderator variable</i>  | <i>Regression coefficients</i> |           |                    |                |                       |
|----------------------------|--------------------------------|-----------|--------------------|----------------|-----------------------|
|                            | Stress                         | Moderator | Stress x moderator | R <sup>2</sup> | R <sup>2</sup> change |
| <b><i>First block</i></b>  | 0.01                           |           |                    |                |                       |
| Restraint                  |                                | -0.14*    |                    |                |                       |
| External eating            |                                | 0.10      |                    |                |                       |
| Emotional eating           |                                | 0.18*     |                    |                |                       |
| Disinhibition              |                                | -0.07     |                    |                |                       |
| Emotional stability        |                                | -0.01     |                    | 0.05*          |                       |
| <b><i>Second block</i></b> | -0.50                          |           |                    |                |                       |
| Restraint                  |                                | -0.26     | 0.23               |                |                       |
| External eating            |                                | -0.04     | 0.45               |                |                       |
| Emotional eating           |                                | 0.15      | 0.09               |                |                       |
| Disinhibition              |                                | -0.002    | -0.13              |                |                       |
| Emotional stability        |                                | 0.02      | -0.08              | 0.05           | 0.01                  |

\*p<0.05

\*\*p<0.01

Table 2.4 shows that the regression model was significant with the first block of variables in predicting the total number of snacks consumed ( $F(6,302)=2.38$ ,  $p<0.05$ ), though only accounted for 5% of the variance. Significant predictors were emotional eating and dietary restraint, where the number of snacks increased as emotional eating increased and dietary restraint decreased. Entering the interaction terms in block two did not improve the predictive power of the model ( $F_{\text{change}}(5,297)=0.55$ , n.s.). The same analysis was conducted for males and females separately. The regression model was significant for males with the first set of predictors ( $F(6,94)=3.15$ ,  $p<0.01$ ) accounting for 16.7% variance, with significant predictor of dietary restraint ( $\beta=-0.29$ ,  $p<0.01$ ). However, the second set of predictors did not improve the predictive power of the model ( $F_{\text{change}}(5,89)=0.82$ , n.s.). In females the model was non significant with the first set of predictors



( $F(6,201)=1.73$ , n.s.) and was not improved by the addition of the interaction terms ( $F_{\text{change}}(5,196)=0.38$ , n.s.).

Table 2.5 shows the coefficients for the predictor variables when the number of unhealthy snacks was entered as the outcome variable. The first set of predictor variables was significant in predicting the number of unhealthy snacks consumed ( $F(6,302)=5.62$ ,  $p<0.01$ ), and accounted for 10% of the variance. As with overall snacks, the significant predictors were emotional eating score and dietary restraint, with an increased number of snacks consumed as emotional eating score increased and dietary restraint decreased. Adding the interaction terms in block two of the regression did not cause any significant change in the model's predictive power ( $F_{\text{change}}(5,297)=0.66$ , n.s.).

**Table 2.5 Effects of moderator variables on the number of unhealthy snacks consumed in the first and second blocks of regression (N=315)**

| <i>Moderator variable</i> | <i>Regression coefficients</i> |           |                    |                |                       |
|---------------------------|--------------------------------|-----------|--------------------|----------------|-----------------------|
|                           | Stress                         | Moderator | Stress x moderator | R <sup>2</sup> | R <sup>2</sup> change |
| <b>First block</b>        | 0.08                           |           |                    |                |                       |
| Restraint                 |                                | -0.26**   |                    |                |                       |
| External eating           |                                | 0.07      |                    |                |                       |
| Emotional eating          |                                | 0.25**    |                    |                |                       |
| Disinhibition             |                                | -0.05     |                    |                |                       |
| Emotional stability       |                                | -0.04     |                    | 0.10*          |                       |
| <b>Second block</b>       | -0.19                          |           |                    |                |                       |
| Restraint                 |                                | -0.30*    | 0.08               |                |                       |
| External eating           |                                | -0.01     | 0.31               |                |                       |
| Emotional eating          |                                | 0.10      | 0.37               |                |                       |
| Disinhibition             |                                | 0.001     | -0.12              |                |                       |
| Emotional stability       |                                | 0.02      | -0.16              | 0.11*          | 0.01                  |

\* $p<0.05$

\*\* $p<0.01$

The regression model was significant for both males ( $F(6,94)=2.62$ ,  $p<0.05$ ) and females ( $F(6,201)=4.46$ ,  $p<0.01$ ), and accounted for 14.3% and 11.8% of the variance in the number of unhealthy snacks for males and females respectively. For male respondents, restrained eating was the only significant predictor with the block one variables ( $\beta=-0.32$ ,  $p<0.01$ ). For females, significant predictors were the

amount of stress experienced on the previous day ( $\beta=0.18$ ,  $p<0.05$ ), emotional eating ( $\beta=0.18$ ,  $p<0.05$ ) and restraint ( $\beta=-0.25$ ,  $p<0.01$ ). In both males and females, increasing dietary restraint was associated with decreased snack intake, but increases in stress levels and emotional eating were associated with increased consumption of unhealthy snacks in females only. The addition of the interaction terms to the model did not increase the predictive power for the males ( $F_{\text{change}}(5,89)=0.86$ , n.s.), nor the females ( $F_{\text{change}}(5,196)=0.86$ , n.s.).

When the number of high fat snacks was entered as an outcome variable, the regression model was significant with the first block of predictor variables ( $F(6,302)=4.77$ ,  $p<0.01$ ), accounting for 8.7% of the variance. The significant predictors were emotional eating ( $\beta=0.19$ ,  $p<0.05$ ) and restraint ( $\beta=-0.26$ ,  $p<0.01$ ). Entering the interaction terms in block two of the regression did not significantly improve the predictive power of the model ( $F_{\text{change}}(5,297)=0.47$ , n.s.). The model was significant in females ( $F(6,201)=4.75$ ,  $p<0.01$ ), and accounted for 12.4% of the variance, with significant predictor variables of reported stress level ( $\beta=0.16$ ,  $p<0.05$ ) and dietary restraint ( $\beta=-0.29$ ,  $p<0.01$ ). As with the number of unhealthy snacks, increasing levels of stress and decreasing restraint were associated with increasing consumption. The addition of the interaction terms did not significantly contribute to the predictive power of the model in females ( $F_{\text{change}}(5,196)=0.36$ , n.s.). The model was non-significant in males with the first block of predictors ( $F(5,94)=1.54$ , n.s.) and after the inclusion of interaction terms ( $F_{\text{change}}(5,89)=0.65$ , n.s.).

The regression model did not significantly predict the number of sweet snacks ( $F(6,302)=1.25$ , n.s.), and the addition of the interaction terms in block two of the regression did not improve the predictive power of the model ( $F_{\text{change}}(5,297)=0.43$ , n.s.). The model was non significant in males with the first block of predictor variables ( $F(6,94)=1.84$ , n.s.) and did not improve with the interaction terms added ( $F_{\text{change}}(5,89)=1.33$ , n.s.). Similarly, the model was non significant in females with the first block of predictors ( $F(6,201)=0.86$ , n.s.) and was not improved by the addition of interaction terms in the second block ( $F_{\text{change}}(5,196)=0.18$ , n.s.).



Likewise, the block one variables did not significantly predict the number of savoury snacks consumed ( $F(6,302)=1.80$ , n.s.) and the additional interaction variables in block two of the regression did not improve the model ( $F_{\text{change}}(5,297)=0.61$ , n.s.). The model was non significant with the first set of predictors in the male respondents ( $F(6,94)=1.44$ , n.s.) and female respondents ( $F(6,201)=1.59$ , n.s.) and did not improve when the interaction terms were added in either males ( $F_{\text{change}}(5,89)=0.45$ , n.s.) or females ( $F_{\text{change}}(5,196)=0.57$ , n.s.).

*Multiple regression analysis of the relationship between stress level and types of snacks consumed the previous day*

The snacks were further classified into specific food types, representing the most commonly reported snacks, to include fruit, sweets/chocolate, crisps/nuts and biscuits/cakes. Pearson's coefficients showed a positive association between reported levels of stress the day before and the number of crisp/nut snacks consumed ( $r=0.11$ ,  $N=313$ ,  $p<0.05$ ). By analysing the males and females separately, it was revealed that the positive association remained strong among the females ( $r=0.19$ ,  $N=211$ ,  $p<0.01$ ), but not within the male respondents ( $r=0.01$ ,  $N=102$ , n.s.).

Forced entry hierarchical regression was conducted with the number of the different types of snack entered as the outcome variables, i.e. fruit, sweets/chocolate, crisps/nuts and biscuits/cakes. As before, stress levels the previous day, eating style and emotional eating were entered in the first block, and the interaction terms between eating style and stress levels were entered in the second block. Table 2.6 shows the beta coefficients for the predictors in the first and second blocks of regression for sweets and chocolate snacks.

Table 2.6 shows that the regression model significantly predicted the number of sweets or chocolate snacks consumed ( $F(6,302)=2.32$ ,  $p<0.05$ ), accounting for 4.4% of the variance. Emotional eating and dietary restraint were significant predictors, where increasing emotional eating and decreasing dietary restraint were associated with increased intake of snacks. The model was only marginally significant after the interaction terms were added ( $F(11,297)=1.64$ ,  $p=0.09$ ).

**Table 2.6 Effects of moderator variables on the number of sweets/chocolate snacks consumed with the first and second blocks of regression (N=315)**

| <i>Moderator variable</i>  | <i>Regression coefficients</i> |           |                    |                |                       |
|----------------------------|--------------------------------|-----------|--------------------|----------------|-----------------------|
|                            | Stress                         | Moderator | Stress x moderator | R <sup>2</sup> | R <sup>2</sup> change |
| <b><i>First block</i></b>  | 0.001                          |           |                    |                |                       |
| Restraint                  |                                | -0.16*    |                    |                |                       |
| External eating            |                                | -0.002    |                    |                |                       |
| Emotional eating           |                                | 0.22**    |                    |                |                       |
| Disinhibition              |                                | -0.01     |                    |                |                       |
| Emotional stability        |                                | -0.01     |                    | 0.04*          |                       |
| <b><i>Second block</i></b> | -0.27                          |           |                    |                |                       |
| Restraint                  |                                | -0.14     | -0.04              |                |                       |
| External eating            |                                | 0.04      | -0.07              |                |                       |
| Emotional eating           |                                | -0.06     | 0.64               |                |                       |
| Disinhibition              |                                | 0.03      | -0.11              |                |                       |
| Emotional stability        |                                | 0.02      | -0.08              | 0.06           | 0.01                  |

\* p<0.05

\*\*p<0.01

The same regression model was tested in males and females separately for the number of sweets and chocolates snacks consumed. The first block of predictor variables did not significantly predict the number of snacks consumed in males ( $F(6,94)=1.42$ , n.s.) or females ( $F(6,201)=1.91$ , n.s.). After the addition of the interaction terms in block two, the model was non-significant for males ( $F(11,89)=1.03$ , n.s.) but significant in females ( $F(11,196)=1.89$ ,  $p<0.05$ ), accounting for 10 % in the variance. For females, the interaction variable of stress the day before by emotional eating score was the only significant predictor ( $\beta=1.27$ ,  $p<0.05$ ).

This interaction between emotional eating and stress levels in female respondents was investigated by dividing the sample into high and low emotional eaters using the median value (median=34) and by gender, to create female high and low emotional eaters and male high and low emotional eaters. Regression analysis was conducted with the first block of variables (i.e. stress level the previous day, eating style and emotional stability). The regression model was only significant in female high emotional eaters ( $F(6,92)=2.81$ ,  $p<0.05$ ), accounting for 12.9% of the variance. Stress level the previous day emerged as the only significant predictor ( $\beta=0.22$ ,



$p < 0.05$ ), showing that as stress levels increased so did the number of sweets and chocolates snacks consumed, in female high emotional eaters.

The same regression model was used to predict the number of crisps and nuts snacks consumed. Table 2.7 shows the beta coefficients for the predictor variables in the model.

**Table 2.7 Effects of moderator variables on the number of crisps and nuts snacks consumed with the first and second blocks of regression (N=315)**

| <i>Moderator variable</i>  | <i>Regression coefficients</i> |           |                    |                |                       |
|----------------------------|--------------------------------|-----------|--------------------|----------------|-----------------------|
|                            | Stress                         | Moderator | Stress x moderator | R <sup>2</sup> | R <sup>2</sup> change |
| <b><i>First block</i></b>  | 0.14*                          |           |                    |                |                       |
| Restraint                  |                                | -0.19**   |                    |                |                       |
| External eating            |                                | -0.01     |                    |                |                       |
| Emotional eating           |                                | 0.06      |                    |                |                       |
| Disinhibition              |                                | 0.06      |                    |                |                       |
| Emotional stability        |                                | -0.08     |                    | 0.05*          |                       |
| <b><i>Second block</i></b> | 0.16                           |           |                    |                |                       |
| Restraint                  |                                | -0.25     | 0.12               |                |                       |
| External eating            |                                | -0.02     | 0.02               |                |                       |
| Emotional eating           |                                | 0.14      | -0.18              |                |                       |
| Disinhibition              |                                | -0.12     | 0.32               |                |                       |
| Emotional stability        |                                | 0.02      | -0.24              | 0.06           | 0.01                  |

\*  $p < 0.05$

\*\*  $p < 0.01$

Table 2.7 shows that the model was significant with the first block of predictors ( $F(6,302)=2.36$ ,  $p < 0.05$ ) and accounted for 4.5% of the variance, with significant predictors of restraint and stress the previous day. Increasing levels of stress and decreasing restraint scores were associated with increases in the number of crisps and nuts snacks consumed. The addition of the interaction terms did not significantly improve the variance accounted for ( $F_{\text{change}}(5,297)=0.70$ , n.s.). The model was non significant with the first set of predictors in both male respondents ( $F(6,94)=1.56$ , n.s.) and female respondents ( $F(6,201)=1.82$ , n.s.), and was not improved by the interaction terms in block two in males ( $F_{\text{change}}(5,89)=0.38$ , n.s.) or females ( $F_{\text{change}}(5,196)=0.65$ , n.s.).

The regression model was not significant in predicting the intake of fruit snacks after the first set of variables ( $F(6,302)=0.41$ , n.s.) nor after the introduction of the

interaction terms ( $F(11,297)=0.55$ , n.s.). The model was unable to predict the intake of fruit snacks in males with the first block of predictors ( $F(6,94)=0.90$ , n.s.) and with the interaction terms included ( $F(11,89)=0.65$ , n.s.). The model was also unable to predict fruit intake in females with the first block of predictors ( $F(6,201)=1.20$ , n.s.) or with the second block of predictors added ( $F(11,196)=0.93$ , n.s.). The regression model was unable to significantly predict the number of cakes or biscuits consumed by the whole sample with the first block of variables ( $F(6,302)=0.28$ , n.s.) or with the interaction terms added ( $F(11,297)=0.54$ , n.s.). The number of cakes and biscuits was not significant predicted in males with the first set of predictors ( $F(6,94)=0.60$ , n.s.) or with the interaction terms added ( $F(11,89)=0.64$ , n.s.). Similarly, the model was not significant in females with the first block of predictors ( $F(6,201)=0.70$ , n.s.) or with the second block ( $F(11,196)=0.94$ , n.s.).

#### **2.2.2.4 Effect of hassle type on snack intake**

Each reported hassle was categorised into hassle types according to the respondent's description. These categories were guided by previous theoretical conceptions of stressor types and discussed with two other independent raters, to provide the following hassle categories: ego threatening (e.g. giving a presentation); interpersonal (e.g. an argument with a family member); physical (e.g. lifting heavy objects); work-related (e.g. high workload); household chores (e.g. doing the washing); and time pressures (e.g. being late to meet someone). The hassle categories were not considered mutually exclusive, and therefore certain hassles encompassing aspects of more than one hassle type were coded into more than one group. There were low frequencies of each hassle, as hassles were only recorded on one day. Therefore, to enable further analysis, the frequency of each type of hassle was recoded to represent either no occurrences of the hassle, or one or more incidences of that type of hassle.

Pearson's Correlation Coefficients found no significant correlations between the number of snacks consumed and the report of ego threatening ( $r=0.03$ , n.s.), physical ( $r=-0.02$ , n.s.); work-related ( $r=-0.02$ , n.s.); chores ( $r=0.03$ , n.s.); time-related ( $r=-0.01$ , n.s.) or interpersonal hassles ( $r=-0.07$ , n.s.). Pearson's also showed no significant relationships between the occurrence of each hassle type and the number of healthy, unhealthy, high fat, savoury and sweet snacks consumed within the



whole sample. There were also no significant correlations between the presence of different hassles and the numbers of fruit, cake/biscuits or crisps/nuts snacks. There was a significant negative correlation between the occurrence of physical hassles and the number of sweets and chocolate snacks ( $r=-0.14$ ,  $p<0.05$ ), showing that fewer sweets and chocolates snacks were consumed when a physical hassles was reported.

Among the female respondents, there was a significant positive relationship between the incidence of physical hassles and fruit snack consumption ( $r=0.17$ ,  $p<0.05$ ), and between the occurrence of ego threatening hassles and savoury snacks ( $r=0.14$ ,  $p<0.05$ ). Therefore females consumed more fruits when physical hassles occurred, and more savoury snacks when ego-threatening hassles occurred. The occurrence of time-related hassles was negatively related to the number of savoury snacks ( $r=-0.17$ ,  $p<0.05$ ) and the number of healthy snacks consumed ( $r=-0.14$ ,  $p<0.05$ ), in females. Therefore females consumed fewer savoury and healthy snacks when time-related hassles were experienced rather than not experienced. Males showed a significant negative relationship between the presence of physical hassles and consumption of sweet snacks ( $r=-0.23$ ,  $p<0.05$ ), which reflected a greater consumption of sweet snacks when no physical hassles were reported.

#### **2.2.2.5 Summary of findings**

The majority of respondents perceived their food and snack intake to increase when stressed, though females were more likely to report a hyperphagic response, and increasing emotional eating score predicted perceptions of increased intake. Stress levels experienced on the previous day predicted increased consumption of crisps and nuts, though not snacks overall, especially in females. The intake of sweets and chocolate snacks increased with stress ratings in female, high emotional eaters. Within the whole sample, the presence of physical hassles was associated with decreases in the intake of sweets and chocolate snacks.

#### **2.2.3 Discussion**

Study One aimed to investigate stress-induced eating in a large student sample, focusing on both the perceptions of stress-related changes in eating behaviour and the relationship between reported daily hassles and snack intake. The study further

aimed to assess the relative role of different possible moderator variables, and to examine more closely the types of hassles affecting snack intake, and food choice in response to stress.

### ***Perceptions of intake under stress***

The respondents differed in their perceptions of the effect of stress on both overall and snack intake, so that perceived effects ranged from eating much less than usual to eating much more than usual. There was a bias towards eating more than usual in the current study, whereas hypophagic and hyperphagic responses to stress were more equally represented in Oliver and Wardle's (1999) survey. The strongest moderators of perceived intake were gender and emotional eating. Females were much more likely to report a hyperphagic response for snacks and overall intake when stressed. Emotional eating significantly predicted eating response perceptions, so that increasing levels of emotional eating were associated with perceptions of increased overall and snack intake under stress. Diet status did not appear to moderate perceptions of intake in the current study, as dieters and non-dieters had very similar perceptions of eating response to stress.

### ***Snack intake with daily hassles***

The overall number of snacks was not associated with stress, the number of hassles or the total intensity of hassles within the whole sample. However, stress ratings did predict the number of crisps and nuts snacks consumed. It is interesting that crisps and nuts consumption should be related to stress, since these are in essence 'crunchy' foods. Previous studies have shown crunchy foods to be preferred during stress in humans (Willenbring et al., 1986), and it has been theorised that crunching foods is a stress-relieving habit similar to gnawing behaviours shown in rodents and nail biting in humans (Morley et al., 1986). Increased consumption of crisps during stress has also been reported by Shapiro and Anderson (2005). Therefore, this finding does correspond with previous research and may support a preference for crunchy foods during stress.

### ***Moderators of snack intake with hassles***

Emotional eating score was a strong predictor of snack consumption with stress among females. The interaction of stress levels and emotional eating was a



predictor of the number of chocolate and sweets snacks consumed in females, such that the number of consumed sweets and chocolate snacks increased with stress ratings, but only in female high emotional eaters. Previous research has also shown emotional eating style to be a strong predictor of eating during stress (e.g. O'Connor et al., 2005; Oliver et al., 2000), although it is interesting that emotional eating only interacted with stress to predict intake in female, but not male, respondents in the current study. Interestingly, both emotional eating and restraint also predicted snack intake in males and females, regardless of stress level, such that increased snack consumption was predicted by increases in emotional eating and decreases in restraint. Therefore these constructs appeared to affect snack intake on a general level.

The evidence for moderating roles of restraint, external eating and disinhibition was not overwhelming in this particular study. None of these variable interacted with stress level to predict snack intake. This conflicts with previous findings of increased snack consumption under stress in restrained eaters (Cools et al., 1992) and in high external eaters (Conner et al., 1999). It is difficult to attribute this difference to the samples involved, as both Conner et al.'s study and the present study employed a student sample. However, stress and snack intake were only recorded over one day in the current study rather than over a weekly period, which may have affected the reliability of the findings.

There was little evidence to suggest that body mass index moderates stress-induced eating from this study. However, many of the measures were highly correlated. External eating was significantly correlated with emotional eating and disinhibition, and emotional eating correlated with dietary restraint and disinhibition. Females were also more likely to be on a diet and score highly on dietary restraint, and BMI was related to diet status. It may be the case that other factors related to BMI are actually more predictive of eating response under stress. Emotional stability did not emerge as a significant predictor of perceived intake, nor did it interact with the stress measures to predict snack intake.

### *Effect of hassle type on snack intake*

Several interesting findings emerged from the analysis of hassle type and snack choice under stress, particularly among the female respondents. Within the overall sample, there were no significant correlations between the presence or absence of each type of hassle and the overall intake of snacks. However, the presence of a physical hassle (an illness, playing sport or lifting heavy objects) was associated with a lower consumption of sweets or chocolate snacks. This corresponds with the previous finding that food intake decreases in response to anticipated physical stressors (Heatherton et al., 1991). O'Connor et al. (2005) also reported that snack intake decreased when physical hassles were experienced. It may be the case, therefore, that psychological, rather than physical, hassles are associated with increased consumption, since previous studies have shown that ego threatening and interpersonal stressors are particularly effective in inducing food intake (e.g. Heatherton et al., 1991; Tanofsky-Kraff et al. 2000). In the current study, it is also possible that the lower snack intake was due to the inclusion of illnesses and hangovers in the physical hassle category, since hassles of this nature may be expected to be associated with a general decrease in food consumption. Interestingly, there was a positive relationship between fruit consumption and the presence of physical hassles in females, which could again be due to the inclusion of illness hassles in this category and a desire to eat healthy foods for recovery. Alternatively, the consumption of fruit snacks may reflect a generally healthy lifestyle among those individuals reporting physical hassles, since exercise was also included in the physical hassles category.

Among the female respondents, there was a positive association between stress ratings and the number of unhealthy snacks consumed, and with crisps and nuts in particular. The presence of time-related stressors was associated with a lower consumption of both healthy and savoury snacks in females, and the presence of ego threatening stressors was related to a greater consumption of savoury snacks. These findings correspond with the conjecture that ego-threatening stressors are particularly potent in inducing food intake (Heatherton et al., 1991). It also seems likely that the very nature of time-related hassles may have meant that there was less time for snack consumption.



### ***Strengths and limitations***

In this particular study, the participants were asked to report their hassles and snacks on the previous day, as well as their perceptions of the effect of stress on food intake. This meant that the hassles represented real daily events experienced by the student population, and the snacks reflected food intake in the natural environment, rather than in a laboratory. The nature of the study also allowed the investigation of stress-induced eating within a large sample. However, the design of the study did impose several limitations. The sample was comprised of students, who may not be representative of the wider population. The stressors faced by students may well differ from those of an older population who are more likely to have children, regular working hours and less flexible eating patterns. A second limitation of Study One is that it offered a ‘snapshot’ of the relationship between hassles and food intake by focusing on one day, whereas a more complete picture of stress-induced eating would be afforded by hassle and intake records over a period of several days or weeks. In particular, a multilevel modelling design where individuals’ behaviour was monitored over a number of days would have the advantage of enabling within-person, as well as between-person, associations to be measured (Affleck et al., 1999). So far, only one study has tested the relationship between hassles and snack intake using a multilevel modelling design (O’Connor et al., 2005). Therefore it would be useful to test the relationship between hassles and snack intake within and between individuals over a number of days, using multilevel modelling.

### ***Conclusions***

The results of Study One suggest that stress-induced eating may be more prevalent in females, but that emotional eating serves to moderate the stress-eating relationship. Stress-induced eating also appears to depend on the type of hassle experienced, whereby ego-threatening stressors may relate to increased snack consumption, and physical and time-related stressors to decreased consumption. Furthermore, snack choice was affected by hassles, such that the intake of crunchy foods was predicted by daily stress. Hassle type and food choice interacted so that the intake of healthy snacks, fruit and sweets and chocolates was related to the presence of difference hassle types, especially in females. To examine these findings further, it is necessary to investigate the relationship between daily hassles and eating behaviour in a non-student sample, over a longer time period.

### **2.3 Study Two: Daily hassles and snack intake in a non-student population**

The main aims of Study Two were to further test the moderators of stress-induced eating, and the role of stressor type in predicting snack intake during stress. To overcome the cross-sectional and sampling limitations of Study One, Study Two investigated the relationship between daily hassles and intake over a two-week period, within a non-student adult sample. The use of two-week diaries in Study Two allowed multilevel modelling to be applied to the data. Multilevel modelling enables researchers to test both between-person and within-person associations, reduces the problem of retrospective recall and allows the same participants to act as control cases (Affleck et al., 1999). Although previous studies have employed diary methodologies, these have not used hierarchical linear modelling to test the relationship between stress and food intake, with the exception of O'Connor et al. (2005). Eating style and personality were measured as possible moderators of the stress-eating relationship.

#### **2.3.1 Method**

##### ***Participants***

One hundred and six people initially volunteered for the study and were sent study packs. Of this original number, 61 respondents completed the first diary and 56 respondents returned diary two, leaving a total sample of 56 respondents completing the study (52.83% response rate). The final sample included 43 females and 14 males, with an age range of 21 to 65 years (mean age=34.47, SD=11.32). The body mass indices ranged from 18.75 to 43.26 within the sample, with a mean of 24.38 (SD=4.66). Thirteen respondents reported that they were currently on a diet (25% of the sample). Most of the sample had a higher education qualification, with a mean of 16.61 (SD=2.63) years in education, and were all currently employed or seeking employment. The respondents were paid twenty pounds for completion of both diaries (Ethics approval for Study Two is shown in Appendix 2.3).

##### ***Procedure***

Respondents were invited to take part in a 'Mood and Eating Survey', and were recruited through flyers, adverts on the University of Leeds website and through participants passing on the study details to friends. Each respondent was sent a



study pack containing instructions, two diaries (labelled ‘Diary One’ and ‘Diary Two’ for weeks one and two) with pre-addressed freepost envelopes, and a battery of questionnaires. Participants were asked to complete daily entries at the end of each day over a period of two weeks, and to post back each diary on its completion, using the freepost envelope. The respondents were also asked to return the questionnaires with either diary.

### ***Questionnaire measures***

The participants were asked to complete a brief questionnaire providing gender, age, height, weight, current occupation, the number of years spent in education, diet status (‘Are you currently on a diet to lose weight?’) and any details of dietary requirements (refer to Appendix 2.4). The participants completed the restrained, emotional and external eating scales of the Dutch Eating Behaviour Questionnaire (DEBQ, Van Strien et al., 1986a) and the disinhibition scale of the Three Factor Eating Questionnaire (TFEQ, Stunkard & Messick, 1985) as in Study One. The DEBQ scales for restraint, emotional and external eating showed very high internal consistencies in the present study (Cronbach’s alpha values of 0.91, 0.96 and 0.89 respectively), as did the disinhibition scale of the TFEQ (alpha value of 0.85). In addition, the participants completed the rigid and flexible control scales of dietary restraint (Westenhoefer et al., 1999). The rigid control scale is designed to measure a strict control of eating behaviour, and contains sixteen items such as, ‘Sometimes I skip meals to avoid gaining weight’ and, ‘I eat diet foods, even if they do not taste very good’. The flexible control scale is intended to measure an adaptable, less ‘all or nothing’ approach to dieting, and contains 12 items including, ‘If I eat a little bit more at one meal, I make up for it at the next meal’. Both scales have shown good internal reliability previously (Westenhoefer et al., 1999), and had high levels of internal reliability in the current sample (Cronbach’s alpha values of 0.82 for both scales).

Perfectionism was measured using the Multidimensional Perfectionism Scale (MPS; Hewitt & Flett, 1991), which includes three 15-item scales designed to measure ‘self-oriented’, ‘other-oriented’ and ‘socially prescribed’ perfectionism. Self-oriented perfectionism is characterised by the setting of high standards for oneself by oneself, and includes items such as, ‘When I am working on something I cannot

relax until it is perfect'. Other-oriented perfectionism describes the setting of high standards for significant others (e.g. 'If I ask someone to do something, I expect it to be done flawlessly'), and socially prescribed perfectionism is characterised by the perception that others hold high, unrealistic standards for oneself (e.g. 'Anything I do that is less than excellent will be seen as poor work by those around me'). The respondent was required to rate the accuracy of each statement on a seven point Likert scale. The MPS scales have been shown to possess good reliability and validity by Hewitt and Flett (1991), and all three scales showed high internal reliabilities in the present study (Cronbach's alpha values of 0.91, 0.86 and 0.89 for self-oriented, other-oriented and socially prescribed perfectionism scales respectively).

Conscientiousness was measured using the 60-item scale from the International Personality Item Pool (IPIP; Goldberg, 1999). The 60-item scale measures five facets of conscientiousness, including Competence (e.g. 'I complete tasks successfully'), Order (e.g. 'I love order and regularity'), Dutifulness (e.g. 'I keep my promises'), Achievement-Striving (e.g. 'I turn plans into actions'); Self-Discipline (e.g. 'I get to work at once') and Deliberation (e.g. 'I choose my words with care'), with the accuracy of each statement rated on a five-point scale, from 'very inaccurate' to 'very accurate'. Conscientiousness has previously been linked to healthy behaviours and eating behaviour in susceptible groups (Friedman et al., 1995; O'Connor & O'Connor, 2004), as mentioned in the Introduction. The 60-item scale has been previously shown to possess high internal reliability (Costa et al., 1991), and also possessed a high internal reliability value in the current sample (Cronbach's alpha of 0.91).

The respondents were also required to complete four ten-item personality subscales from the online IPIP (Goldberg, 1999) measuring extraversion (e.g. 'I am the life of the party'), emotional stability (e.g. 'I seldom feel blue'), agreeableness (e.g. 'I sympathise with others' feelings') and intellect/imagination (e.g. 'I have a vivid imagination') scales. These were measured using the same five-point accuracy scale as conscientiousness, and have been shown to possess high internal reliability (Goldberg, 1999). These personality scales also showed high reliability in the current sample (Cronbach's alpha values of 0.86, 0.76, 0.91 and 0.84 for



extraversion, agreeableness, emotional stability and intellect/imagination respectively).

### *Daily diary measures*

The week one and two diaries asked the participants to record stress and food intake each day (daily measures are shown in Appendix 2.5). Each day the participant was prompted to record any snacks consumed between meals. As a record of stress and hassles, the participants reported any specific hassles experienced that day and rated the intensity of the hassle on a four-point anchored scale from ‘not at all’ to ‘very much’, in the same way as the respondents in Study One reported the hassles from the previous day. In addition, the diary respondents rated the extent to which each hassle fitted into the following categories: Health/body related, feelings-related, person-related, work-related and time-related. These categories were based on the physical, ego-threatening, interpersonal, work and time hassle categories respectively, derived from Study One; however, participants, rather than researchers, categorised the hassles in Study Two to improve the validity of the coding process. The participants were provided with a definition and examples for each hassle type.

At the end of each day, the respondents also completed the Hassles and Uplifts Scale (HUPS; DeLongis et al., 1988). The HUPS provides a list of 53 items (e.g. workload, friends and cooking) and requires the participant to rate how much each item was a hassle or uplift that day by circling a number on a four-point scale from ‘none or not applicable’ to ‘a great deal’. The participant also completed the shortened version of the Positive and Negative Affect Scale (PANAS; MacKinnon et al., 1999) at the end of each day, circling the extent that they had felt each of ten emotional states on a five-point Likert scale from ‘very slightly/not at all’ to ‘extremely’.

### *Statistical analysis*

Pearson’s Product-Moment Correlation Coefficients were calculated between gender, diet status, eating style and personality, to test the relationships between moderator variables. Hierarchical linear modelling was conducted using the program HLM6 (Raudenbush et al., 2004), to examine the relationship between

daily hassles and snacks within individuals (level 1 data), and the moderating role of eating style and personality (level 2 data).

## 2.3.2 Results

### 2.3.2.1 Correlations between diet status, gender, eating style and personality

Pearson's coefficients were calculated between gender, diet status, eating style and personality, and are displayed in Table 2.8. Gender was positively correlated with dietary restraint and emotional eating (both  $p < 0.05$ ). Independent t-tests showed that females scored more highly on emotional eating ( $t(54) = -2.40$ ,  $p < 0.05$ ) and restraint ( $t(54) = -2.40$ ,  $p < 0.05$ ). Conscientiousness was also significantly correlated with gender ( $p < 0.05$ ), as females scored more highly on this measure ( $t(54) = -2.07$ ,  $p < 0.05$ ). Diet status was significantly associated with restraint and disinhibition (both  $p < 0.01$ ), with dieters scoring more highly on restraint ( $t(54) = 5.44$ ,  $p < 0.01$ ) and disinhibition ( $t(54) = 3.66$ ,  $p < 0.01$ ). Diet status was also significantly related to perfectionism ( $p < 0.05$ ) and emotional stability ( $p < 0.01$ ), with dieters scoring more highly on perfectionism ( $t(54) = 2.18$ ,  $p < 0.05$ ) and less highly on emotional stability ( $t(54) = -3.35$ ,  $p < 0.01$ ).

The personality measures showed significant correlations with eating style. Conscientiousness was positively related to dietary restraint and flexible control (both  $p < 0.05$ ), showing that both measures of restraint increased with increasing conscientiousness scores. Dietary restraint was positively associated with both perfectionism and agreeableness (both  $p < 0.05$ ), showing that as restraint increased so did levels of perfectionism and agreeableness. Emotional stability was significantly negatively related to dietary restraint, emotional eating, disinhibition, and flexible and rigid control. As each of the eating style variables increased, levels of emotional stability decreased.

Table 2.8 also shows that the eating style variables were strongly correlated with each other. Disinhibition was positively related to DEBQ dietary restraint ( $p < 0.05$ ) and rigid control ( $p < 0.01$ ). Emotional eating score was positively associated with external eating and disinhibition (both  $p < 0.01$ ), and external eating was significantly associated with disinhibition score ( $p < 0.01$ ).



Table 2.8 Pearson’s correlation coefficients between gender, diet status, eating style and personality (N=56)

|                  | <i>Gender</i> | <i>Diet</i> | <i>Restrain</i> | <i>Emotion</i> | <i>Extern</i> | <i>Disinhib</i> | <i>Flex</i> | <i>Rig</i> | <i>Perfect</i> | <i>Conscien</i> | <i>Emot</i> | <i>Intellect</i> | <i>Agree</i> | <i>Extrav</i> |
|------------------|---------------|-------------|-----------------|----------------|---------------|-----------------|-------------|------------|----------------|-----------------|-------------|------------------|--------------|---------------|
|                  |               |             |                 |                |               |                 | <i>con</i>  | <i>con</i> |                |                 | <i>stab</i> |                  |              |               |
| <i>Gender</i>    | -             | -0.02       | 0.31*           | 0.31*          | 0.12          | 0.26            | 0.24        | 0.15       | 0.09           | 0.27*           | 0.004       | -0.04            | 0.21         | -0.03         |
| <i>Diet</i>      |               | -           | -0.60**         | -0.22          | -0.17         | -0.45**         | -0.40**     | -0.65**    | -0.28*         | 0.003           | 0.42**      | 0.07             | -0.16        | -0.07         |
| <i>Restrain</i>  |               |             | -               | 0.18           | 0.06          | 0.32*           | 0.84**      | 0.82**     | 0.30*          | 0.33*           | -0.42**     | -0.12            | 0.32*        | 0.06          |
| <i>Emotion</i>   |               |             |                 | -              | 0.69**        | 0.80**          | 0.15        | 0.20       | 0.16           | 0.05            | -0.33*      | -0.07            | 0.14         | 0.09          |
| <i>External</i>  |               |             |                 |                | -             | 0.69**          | 0.05        | 0.10       | 0.23           | -0.12           | -0.26       | 0.05             | 0.06         | 0.17          |
| <i>Disinhib</i>  |               |             |                 |                |               | -               | 0.16        | 0.42**     | 0.18           | 0.07            | -0.30*      | 0.05             | 0.31*        | 0.22          |
| <i>Flex con</i>  |               |             |                 |                |               |                 | -           | 0.64**     | 0.26           | 0.34*           | -0.30*      | -0.15            | 0.39**       | 0.004         |
| <i>Rig con</i>   |               |             |                 |                |               |                 |             | -          | 0.34*          | 0.19            | -0.44**     | -0.09            | 0.29*        | -0.003        |
| <i>Perfect</i>   |               |             |                 |                |               |                 |             |            | -              | 0.23            | -0.41**     | -0.11            | 0.02         | -0.07         |
| <i>Conscient</i> |               |             |                 |                |               |                 |             |            |                | -               | 0.02        | 0.11             | 0.25         | 0.25          |
| <i>Emot stab</i> |               |             |                 |                |               |                 |             |            |                |                 | -           | 0.21             | 0.01         | 0.20          |
| <i>Intellect</i> |               |             |                 |                |               |                 |             |            |                |                 |             | -                | 0.09         | 0.08          |
| <i>Agreeable</i> |               |             |                 |                |               |                 |             |            |                |                 |             |                  | -            | 0.27*         |
| <i>Extrav</i>    |               |             |                 |                |               |                 |             |            |                |                 |             |                  |              | -             |

\* Significant at p<0.05      \*\*Significant at p<0.01

### 2.3.2.2 Hierarchical linear modelling of the relationship between hassles and snack intake

Hierarchical linear modelling was applied to the data to map the relationship between stress and snack intake, using the number and intensity of daily hassles as level one (within-person) predictors, and the eating style and personality measures as level two variables, or ‘higher order’ predictors of daily snack intake (Steiger et al., 1999). Individual days were coded from one to fourteen to represent fourteen ‘person-days’ for each participant. Each of the 56 respondents completed fourteen diary days, providing a total of 784 person-days. A mean of 1.30 hassles was reported each day, with a range of zero to five hassles. The number of hassles reported was unevenly distributed, with a mode of 1 hassle. Therefore the variable was recoded into high or low number of hassles to make the distribution as equal as possible, where no or one hassles was categorised as a low number, and 2 or more hassles was categorised as a high number of hassles. This meant that 62% days were categorised as low hassle days, and the remaining 38% as high number of hassles days. The number of snacks consumed ranged from zero to six, with a mean of 1.72 snacks per day.

#### *Relationship between number of daily hassles, affect and snack intake*

The relationship between the number of hassles, negative affect, daily hassles and uplifts and the number of daily snacks consumed was tested using the level one model:

$$Y_i = \beta_0 + \beta_1 + \varepsilon_i$$

Where  $Y_i$ =the outcome variable of the number of daily snacks,  $\beta_0$ =the intercept,  $\beta_1$ =the slope for the level one predictor variable and  $\varepsilon_i$ =the random error term.

The predictor variables of hassle number, negative affect, daily hassles score and daily uplifts score were entered individually into the equation (i.e. number of snacks= $\beta_0$  + number of hassles +  $\varepsilon_i$ ; number of snacks= $\beta_0$  + negative affect score +  $\varepsilon_i$ ; number of snacks= $\beta_0$  + daily uplifts score +  $\varepsilon_i$ ). A high or low number of daily hassles was significantly related to the number of daily snacks ( $\beta=0.25$ ,  $t=3.36$ ,  $p<0.01$ ), showing that with an increase of one hassle, the number of snacks consumed increased by 0.25. Daily negative affect score was not significantly



related to snack intake ( $\beta=0.02$ ,  $t=1.76$ , n.s.). Daily hassles score was significantly associated with the number of daily snacks consumed ( $\beta=0.01$ ,  $t=3.09$ ,  $p<0.01$ ), as was daily uplifts score ( $\beta=0.01$ ,  $t=3.08$ ,  $p<0.01$ ) from the Hassles and Uplifts Scale. The coefficients indicated that there was an increase in the number of snacks with increasing daily uplifts and increasing daily hassles scores.

***Moderator effects of eating style on the relationship between the number of hassles and snack intake***

To test whether the relationship between hassle number and snack intake was moderated by eating style, each eating style variable was entered into the equation:

$$Y_{ij} = \beta_{0j} + \beta_{1j} + \varepsilon_{ij}$$

Where  $Y_{ij}$  is the total number of snacks,  $\beta_{0j}$ =the intercept for the eating style variable,  $\beta_{1j}$ =the coefficient for the number of hassles at each eating style unit and  $\varepsilon_{ij}$ =the random error for level one units within the level two units.

Each eating style variable was entered individually into the model, so that the effect of each moderator was considered one at a time, rather than simultaneously. Each eating style variable was entered as a grand centred variable following the recommendations of Kreft et al. (1995). The predictive effects of each eating style variable and cross-level interactions with hassle number are shown in Table 2.9.

**Table 2.9 Cross-level interactions of number of hassles with individual eating style measures in relation to the number of daily snacks (N=56)**

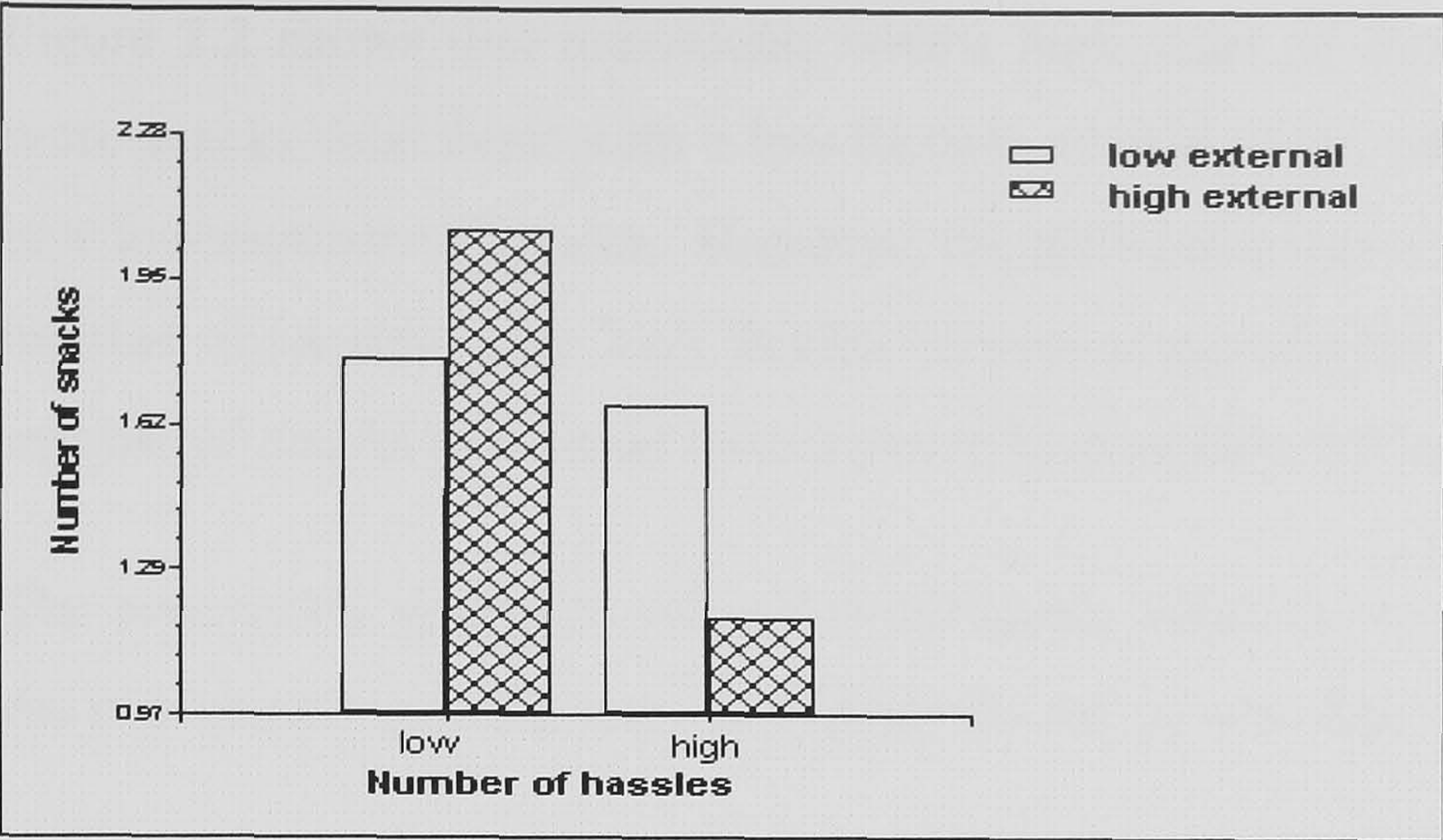
| <i>Individual<br/>moderator</i> | <i>Predictor</i>         | <i>Number of snacks</i> |      |         |
|---------------------------------|--------------------------|-------------------------|------|---------|
|                                 |                          | $\beta$                 | SE   | t-value |
| <i>Restraint</i>                | Number of hassles        | 0.27                    | 0.07 | 3.62**  |
|                                 | Restraint                | -0.001                  | 0.02 | -0.01   |
|                                 | Restraint * hassles      | 0.01                    | 0.01 | 1.46    |
| <i>Emotional eating</i>         | Number of hassles        | 0.24                    | 0.07 | 3.28**  |
|                                 | Emotional eating         | 0.02                    | 0.01 | 1.65    |
|                                 | Emotional*hassles        | -0.01                   | 0.01 | -1.08   |
| <i>External eating</i>          | Number of hassles        | 0.25                    | 0.07 | 3.37**  |
|                                 | External eating          | 0.03                    | 0.02 | 1.77    |
|                                 | External*hassles         | -0.02                   | 0.01 | -2.02*  |
| <i>Disinhibition</i>            | Number of hassles        | 0.24                    | 0.07 | 3.32**  |
|                                 | Disinhibition            | 0.05                    | 0.04 | 1.41    |
|                                 | Disinhibition*hassles    | -0.03                   | 0.02 | -1.47   |
| <i>Rigid control</i>            | Number of hassles        | 0.26                    | 0.07 | 3.57**  |
|                                 | Rigid control            | -0.08                   | 0.04 | -1.95   |
|                                 | Rigid control*hassles    | 0.04                    | 0.02 | 1.93    |
| <i>Flexible control</i>         | Number of hassles        | 0.28                    | 0.07 | 3.81**  |
|                                 | Flexible control         | -0.05                   | 0.05 | -0.94   |
|                                 | Flexible control*hassles | 0.07                    | 0.03 | 2.47*   |

\* Significant at  $p < 0.05$       \*\* Significant at  $p < 0.01$

N.B. The coefficients in Table 2.9 are unstandardised

Table 2.9 shows that there were no direct individual effects of the eating style variables on the number of snacks consumed (all n.s.). External eating interacted with the number of hassles to affect the number of snacks consumed ( $\beta = -0.02$ ,  $t = -2.02$ ,  $p < 0.05$ ). The negative coefficient indicated that as external eating increased, the relationship between a high or low number of hassles and the number of snacks consumed weakened. To explore the interaction further, the number of snacks consumed with a high and low number of hassles was plotted with the maximum and minimum external eating scores, in Figure 2.1.

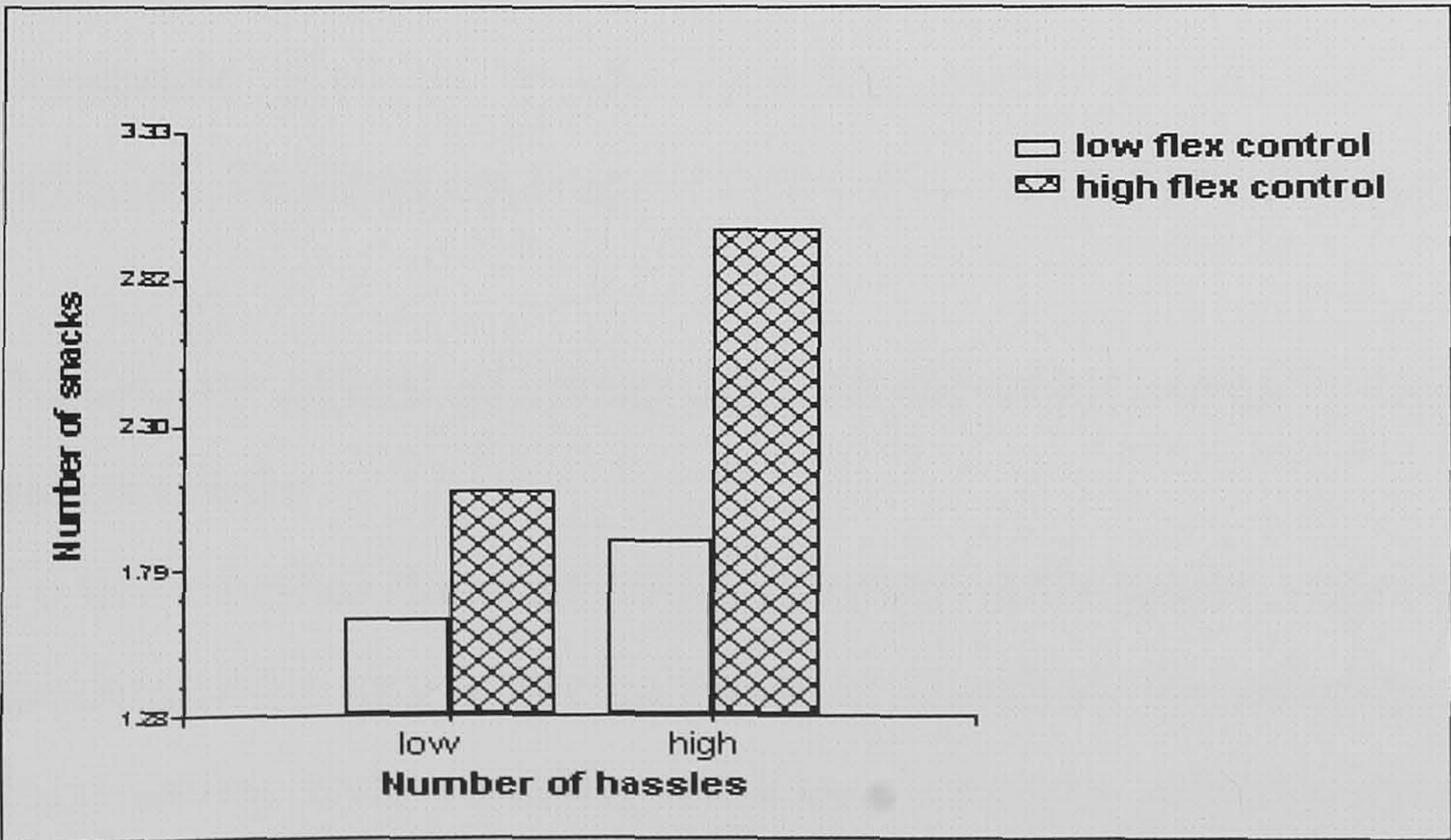




**Figure 2.1    Interaction between hassle number and external eating score in predicting number of snacks consumed**

Figure 2.1 shows that the individuals with the greatest external eating score consumed a greater number of snacks with a low number of hassles than with a high number of hassles. Therefore the high external eaters appeared to decrease snack consumption when a greater number of hassles was experienced. In contrast, those individuals with the lowest external eating score consumed a similar number of snacks with either a high or low number of hassles.

Flexible control restraint score also interacted with the number of hassles to affect snack intake ( $\beta=0.07$ ,  $t=2.47$ ,  $p<0.05$ ). The coefficient suggested that there was a stronger relationship between the number of hassles and snack consumption as flexible control increased. Figure 2.2 shows the number of snacks for minimum and maximum flexible control scores with high and low number of hassles.



**Figure 2.2    Interaction between hassle number and flexible control restraint score in predicting the number of snacks**



Figure 2.2 shows that individuals with a high score of flexible control consumed more snacks than those with a low flexible control score, whether there was a high or a low number of hassles. However, the difference was much greater with a high number of hassles. The high flexible control group showed a large increase in the number of snacks consumed from a low to high number of hassles.

The personality measures did not significantly relate to the number of snacks and did not interact with the number of daily hassles to associate with snack intake.

### ***Relationship between the intensity of daily hassles and snack intake***

The total intensities of reported daily hassles ranged from 0 to 12. As the intensities of hassles were positively skewed, the median value was used to dichotomise the variable into low and high intensity groups. Total intensities of two or fewer were categorised as low intensities, and those of three or more were categorised as high intensity hassle days. This meant that 61% days were classified as high hassle intensity days, and 39% were classified as low hassle intensity days. Hassle intensity was entered into the level one model:

$$Y_i = \beta_0 + \beta_1 + \varepsilon_i$$

Where  $Y_i$ =the outcome variable of the number of daily snacks,  $\beta_0$ =the intercept,  $\beta_1$ =the slope for the level one predictor variable, hassle intensity and  $\varepsilon_i$ =the random error term.

The total intensity of daily hassles was significantly related to the number of snacks consumed ( $\beta=0.19$ ,  $t=2.54$ ,  $p<0.05$ ), where an increase in hassle intensity was associated with an increase in the number of snacks consumed.

### ***Moderator effects of eating style on the relationship between hassle intensity and snack intake***

To test whether the relationship between daily hassle intensity and snack intake was moderated by any of the eating style variables, the cross-level interactions between each eating style variable and hassle intensity were examined. Each eating style variable was individually added as a grand centred variable to the equation:

$$Y_{ij} = \beta_{0j} + \beta_{1j} + \varepsilon_{ij}$$



Where  $Y_{ij}$  is the total number of snacks,  $\beta_{0j}$ =the intercept for the eating style variable,  $\beta_{1j}$ =the coefficient for the number of hassles at the eating style unit and  $\varepsilon_{ij}$ =the random error for level one units within the level two units.

Table 2.10 reports the effects of the individual eating style variables, and their cross-level interactions with hassle intensity, to predict the number of snacks consumed.

**Table 2.10 Effects of eating style and interactions with intensity level in predicting the number of snacks consumed (N=56)**

| <i>Individual<br/>moderator</i> | <i>Predictor</i>         | <i>Number of snacks</i> |      |         |
|---------------------------------|--------------------------|-------------------------|------|---------|
|                                 |                          | $\beta$                 | SE   | t-value |
| <i>Restraint</i>                | Intensity of hassles     | 0.18                    | 0.07 | 2.51*   |
|                                 | Restraint                | 0.03                    | 0.02 | 1.62    |
|                                 | Restraint * hassles      | -0.01                   | 0.01 | -0.92   |
| <i>Emotional eating</i>         | Intensity of hassles     | 0.17                    | 0.07 | 2.35*   |
|                                 | Emotional eating         | 0.03                    | 0.01 | 2.50*   |
|                                 | Emotional*hassles        | -0.01                   | 0.01 | -2.11*  |
| <i>External eating</i>          | Intensity of hassles     | 0.18                    | 0.07 | 2.49*   |
|                                 | External eating          | 0.03                    | 0.02 | 1.27    |
|                                 | External*hassles         | -0.01                   | 0.01 | -1.20   |
| <i>Disinhibition</i>            | Intensity of hassles     | 0.18                    | 0.07 | 2.48*   |
|                                 | Disinhibition            | 0.05                    | 0.04 | 1.31    |
|                                 | Disinhibition*hassles    | -0.02                   | 0.02 | -1.19   |
| <i>Rigid control</i>            | Intensity of hassles     | 0.18                    | 0.07 | 2.52*   |
|                                 | Rigid control            | -0.01                   | 0.04 | -0.37   |
|                                 | Rigid control*hassles    | -0.01                   | 0.02 | -0.38   |
| <i>Flexible control</i>         | Intensity of hassles     | 0.19                    | 0.07 | 2.59*   |
|                                 | Flexible control         | 0.04                    | 0.05 | 0.86    |
|                                 | Flexible control*hassles | 0.001                   | 0.03 | 0.05    |

\* Significant at  $p < 0.05$

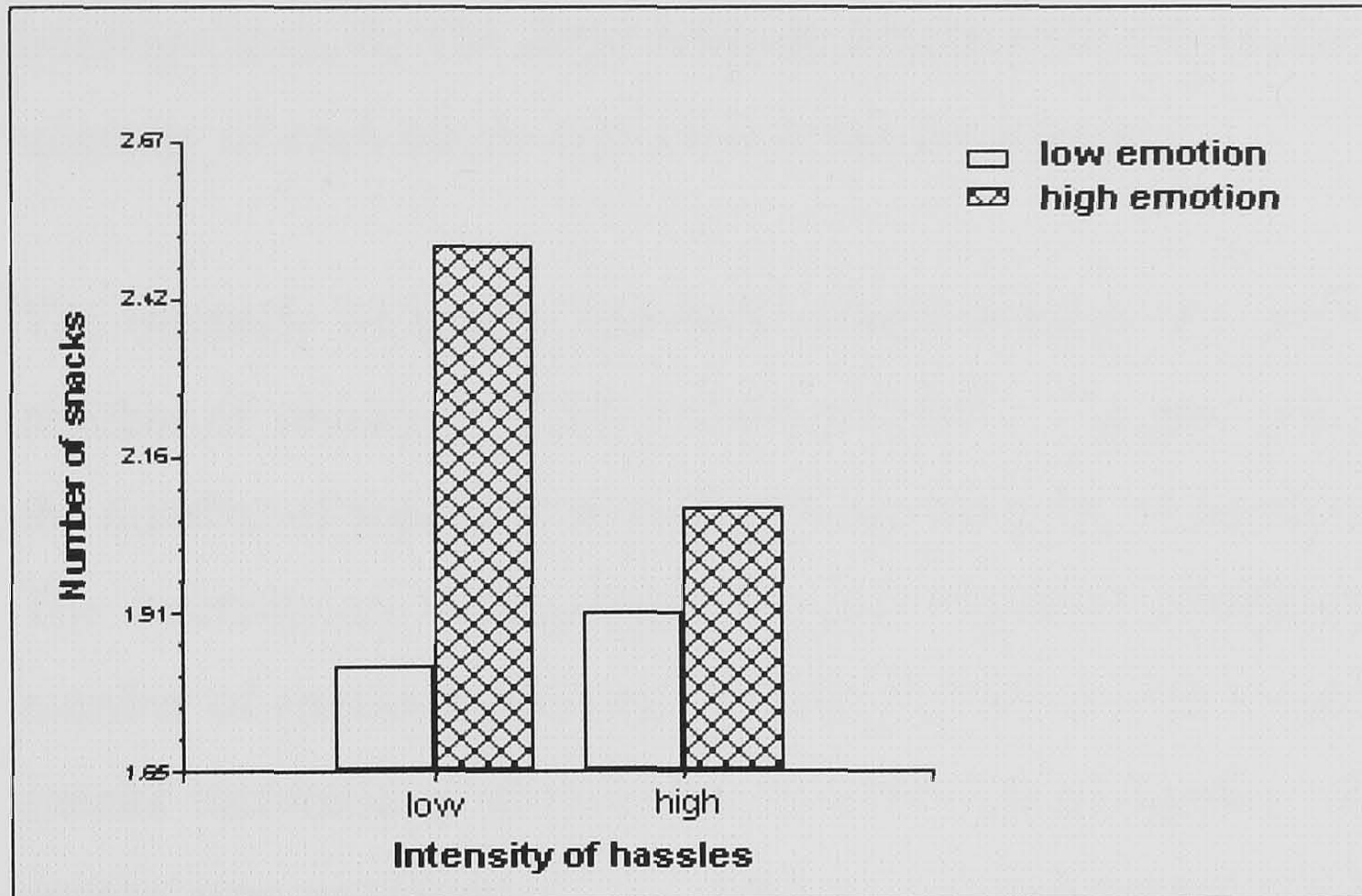
\*\*Significant at  $p < 0.01$

N.B. The coefficients in Table 2.10 are unstandardised

Table 2.10 shows that only emotional eating score from the eating style variables was significantly related to the number of snacks ( $\beta=0.03$ ,  $t=2.50$ ,  $p<0.05$ ). The positive coefficient indicated that as emotional eating increased, so did the number



of snacks consumed. Emotional eating also significantly interacted with the intensity of hassles ( $\beta=-0.01$ ,  $t=-2.11$ ,  $p<0.05$ ). Figure 2.3 shows the number of snacks consumed with high and low hassle intensities for individuals with the minimum and maximum emotional eating scores.



**Figure 2.3 Interaction between hassle intensity and emotional eating score in predicting number of snacks consumed**

It can be seen from Figure 2.3 that individuals with high emotional eating scores consumed a greater number of snacks than low emotional eaters when either low or high hassle intensities were reported. However, the low emotional eaters increased snack consumption with greater hassle intensities, while the high emotional eaters consumed a greater number of snacks with low hassle intensities.

None of the personality variables interacted with the intensity of daily hassles to relate to the number of snacks consumed.

### ***Effect of hassle type on snack intake***

The respondents rated the intensity of each recorded hassle against different hassle categories, including health/body, feelings-related, person-related, work-related and time-related. Not every type of hassle was experienced on each day, meaning that hassle intensities for each type were frequently zero. The intensity for each hassle type was dichotomised into high and low ratings using the median value to enable the most even distributions between a low or high intensity. Each hassle intensity



variable was entered individually into the level one equation below as an uncentred variable:

$$Y_i = \beta_0 + \beta_1 + \varepsilon_i$$

Where  $Y_i$ =the within-person variations in the number of snacks consumed,  $\beta_0$ =the intercept term,  $\beta_1$ =the slope estimate for the level one predictor variable (high or low intensity of each hassle type) and  $\varepsilon_i$ =the error term.

The intensity of health and body-related hassles was significant in predicting the number of snacks ( $\beta=0.18$ ,  $t=2.36$ ,  $p<0.05$ ). The positive coefficient indicated that the number of snacks increased with the intensity of health and body-related hassles. The intensity of work-related hassles was also significantly associated with the number of snacks consumed ( $\beta=0.17$ ,  $t=2.47$ ,  $p<0.05$ ), showing that the number of snacks increased with intensity of work-related hassles. However, the number of snacks was unrelated to the intensity of feelings-related hassles ( $\beta=0.03$ ,  $t=0.46$ , n.s.), and the intensity of person-related hassles ( $\beta=-0.02$ ,  $t=-0.24$ , n.s.). The intensity of time-related hassles was marginally significantly related to the number of snacks consumed ( $\beta=0.14$ ,  $t=1.95$ ,  $p=0.06$ ), showing that there was a slight increase in the number of snacks with a greater intensity of time-related hassles but this did not reach significance.

***Moderating effect of eating style on the relationship between intensities of each hassle type and snack intake***

To test the moderating role of each eating style variable on the relationship between the health/body and work hassle intensities and snack intake, each eating style variable was entered individually into the equation:

$$Y_{ij} = \beta_{0j} + \beta_{1j} + \varepsilon_{ij}$$

Where  $Y_{ij}$  is the total number of snacks,  $\beta_{0j}$  is the intercept for the eating style variable,  $\beta_{1j}$  is the coefficient for the intensity of each hassle type at the eating style unit and  $\varepsilon_{ij}$  is the random error for level one units within the level two units.

This model was conducted with each hassle type with each eating style variable separately. Table 2.11 shows the effect of the eating style variables and cross-level

interactions with health and body-related hassles on the number of snacks consumed.

**Table 2.11 Effects of eating style and interactions with intensity level of health/body hassles in predicting the number of snacks consumed (N=56)**

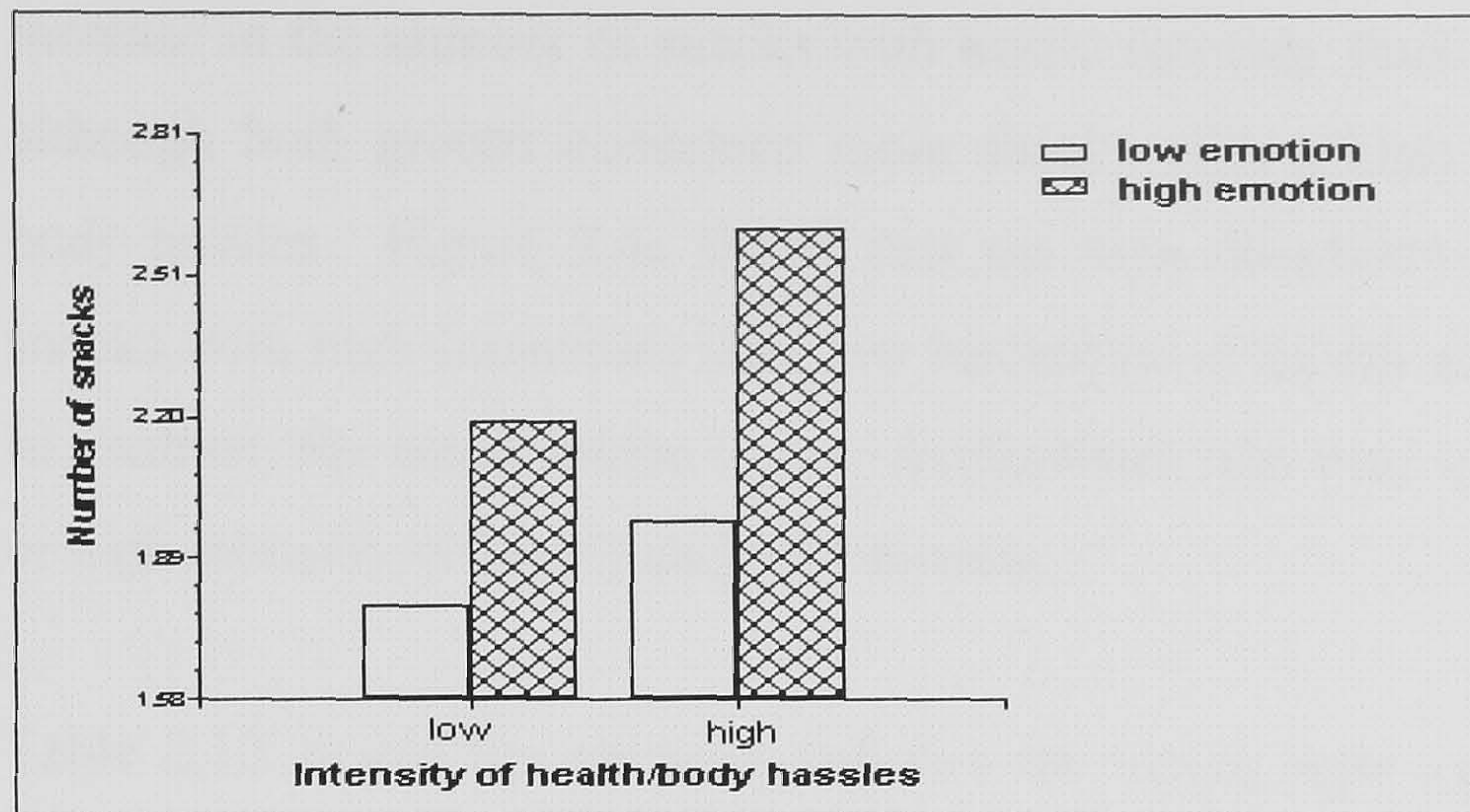
| <i>Individual<br/>moderator</i> | <i>Predictor</i>              | <i>Number of snacks</i> |      |         |
|---------------------------------|-------------------------------|-------------------------|------|---------|
|                                 |                               | $\beta$                 | SE   | t-value |
| <i>Restraint</i>                | Intensity health/body hassles | 0.18                    | 0.08 | 2.37*   |
|                                 | Restraint                     | 0.02                    | 0.02 | 1.22    |
|                                 | Restraint * hassles           | - 0.004                 | 0.01 | -0.05   |
| <i>Emotional eating</i>         | Intensity health/body hassles | 0.17                    | 0.08 | 2.17*   |
|                                 | Emotional eating              | -0.01                   | 0.01 | -0.70   |
|                                 | Emotional*hassles             | 0.01                    | 0.01 | 2.36*   |
| <i>External eating</i>          | Intensity health/body hassles | 0.17                    | 0.08 | 2.15*   |
|                                 | External eating               | -0.03                   | 0.02 | -1.59   |
|                                 | External*hassles              | 0.03                    | 0.01 | 2.74**  |
| <i>Disinhibition</i>            | Intensity health/body hassles | 0.16                    | 0.08 | 2.07*   |
|                                 | Disinhibition                 | -0.06                   | 0.04 | -1.64   |
|                                 | Disinhibition*hassles         | 0.06                    | 0.02 | 2.94**  |
| <i>Rigid control</i>            | Intensity health/body hassles | 0.19                    | 0.08 | 2.42*   |
|                                 | Rigid control                 | -0.04                   | 0.04 | -0.86   |
|                                 | Rigid control*hassles         | 0.003                   | 0.02 | 0.16    |
| <i>Flexible control</i>         | Intensity health/body hassles | 0.18                    | 0.08 | 2.36*   |
|                                 | Flexible control              | 0.05                    | 0.05 | 1.06    |
|                                 | Flexible control*hassles      | -0.01                   | 0.03 | -0.38   |

\*Significant at  $p < 0.05$  \*\*Significant at  $p < 0.01$

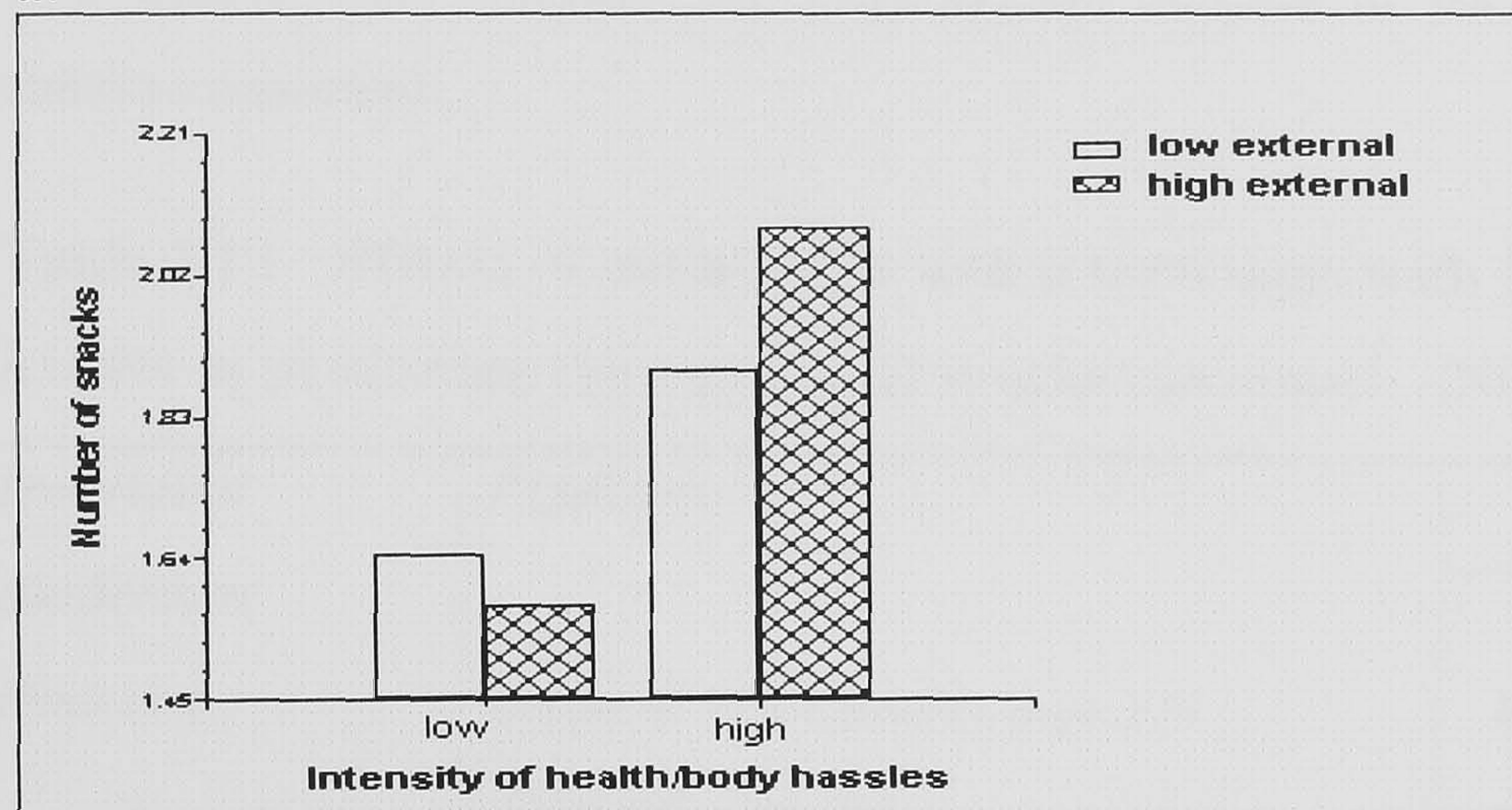
N.B. The coefficients in Table 2.11 are unstandardised.

Table 2.11 shows that the intensity of health and body related hassles interacted with emotional eating score, ( $\beta=0.01$ ,  $t=2.36$ ,  $p<0.05$ ), external eating score ( $\beta=0.03$ ,  $t=2.74$ ,  $p<0.01$ ) and disinhibition ( $\beta=0.06$ ,  $t=2.94$ ,  $p<0.01$ ). Figure 2.4 shows the number of snacks consumed with a low or high intensity of body and health hassles, for low and high scores on each of these eating style variables.

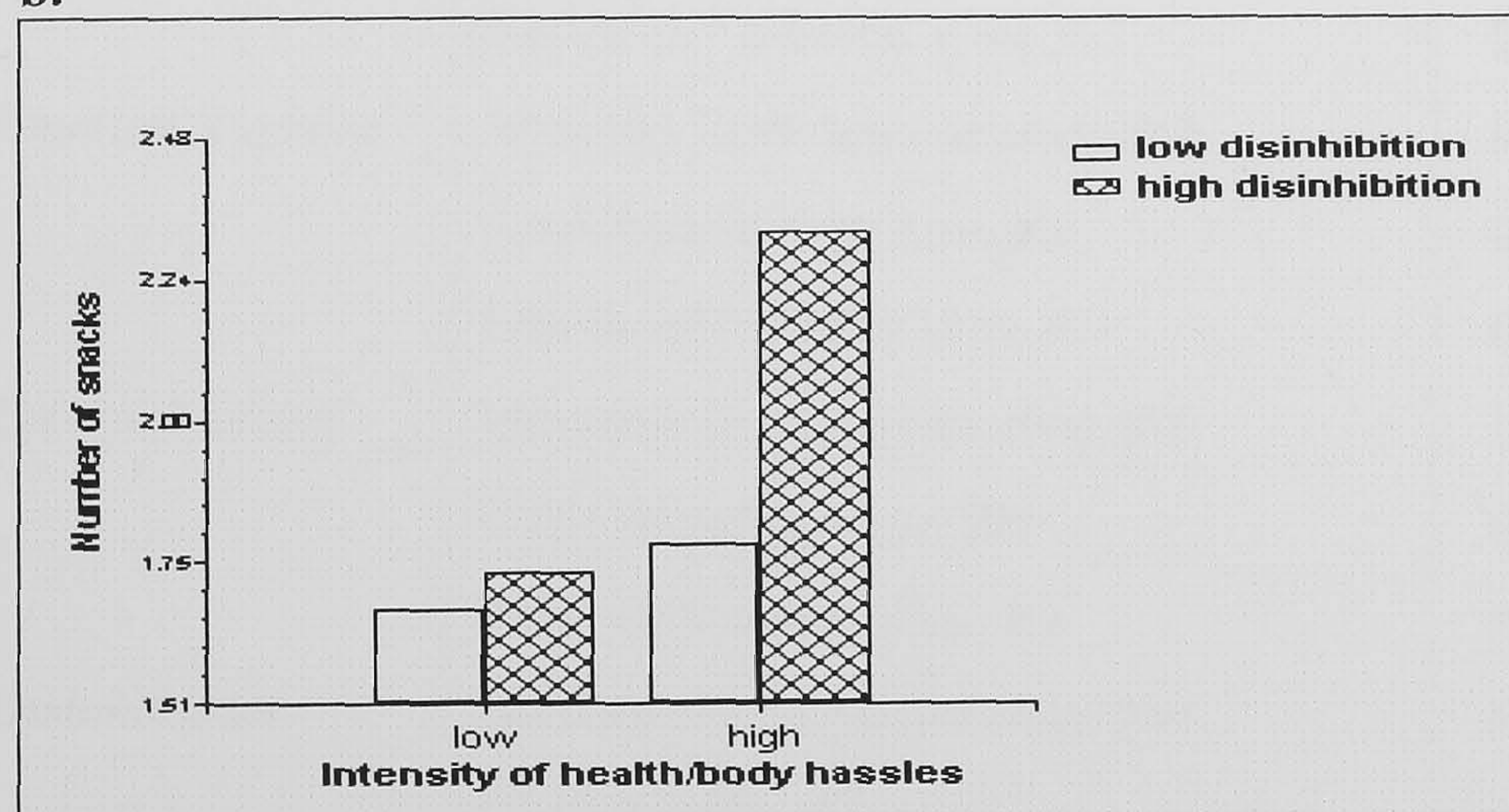




a.



b.



c.

**Figure 2.4 Number of snacks consumed with low or high intensity of health/body hassles for a. low and high emotional eating scores, b. low and high external eaters and c. low and high disinhibitors**

Figure 2.4a shows that high emotional eaters consumed a greater number of snacks than low emotional eaters with both low and high intensities of body and health hassles. However, the high emotional eaters showed a greater increase in snack intake with hassle intensity than low emotional eaters. Figure 2.4b shows that high external eaters were similar to the high emotional eaters, as they showed a greater



increase in the number of snacks with hassle intensity than did low external eaters, although both groups consumed more snacks with a high intensity of health and body hassles. Figure 2.4c shows that the high disinhibitors reported many more snacks with high intensities than low intensities of health and body related hassles. In contrast, the snack intake of low disinhibitors was very similar with either a low or high intensity of health and body hassles.

Table 2.12 shows the relations between the eating style variables and cross level interactions with intensity of work-related hassles in predicting the number of snacks consumed.

**Table 2.12 Effects of eating style and interactions with intensity level of work hassles in predicting the number of snacks consumed (N=56)**

| <i>Individual<br/>moderator</i> | <i>Predictor</i>   | <i>Number of snacks</i> |      |         |
|---------------------------------|--|-------------------------|------|---------|
|                                 |  | $\beta$                 | SE   | t-value |
| <i>Restraint</i>                | Intensity work hassles <i>slope, <math>\beta_{10}</math></i>   | 0.18                    | 0.07 | 2.63*   |
|                                 | Restraint <i>slope, <math>\beta_{01}</math></i>                | -0.01                   | 0.02 | -0.87   |
|                                 | Restraint * hassles, <i>slope, <math>\beta_{11}</math></i>     | 0.02                    | 0.01 | 2.73**  |
| <i>Emotional eating</i>         | Intensity work hassles <i>slope, <math>\beta_{10}</math></i>   | 0.17                    | 0.07 | 2.40*   |
|                                 | Emotional eating <i>slope, <math>\beta_{01}</math></i>         | 0.01                    | 0.01 | 0.74    |
|                                 | Emotional*hassles <i>slope, <math>\beta_{11}</math></i>        | 0.001                   | 0.01 | 0.30    |
| <i>External eating</i>          | Intensity work hassles <i>slope, <math>\beta_{10}</math></i>   | 0.17                    | 0.07 | 2.43*   |
|                                 | External eating <i>slope, <math>\beta_{01}</math></i>          | 0.01                    | 0.02 | 0.30    |
|                                 | External*hassles <i>slope, <math>\beta_{11}</math></i>         | 0.001                   | 0.01 | 0.14    |
| <i>Disinhibition</i>            | Intensity work hassles <i>slope, <math>\beta_{10}</math></i>   | 0.18                    | 0.07 | 2.56*   |
|                                 | Disinhibition <i>slope, <math>\beta_{01}</math></i>            | -0.03                   | 0.04 | -0.74   |
|                                 | Disinhibition*hassles <i>slope, <math>\beta_{11}</math></i>    | 0.03                    | 0.02 | 1.70    |
| <i>Rigid control</i>            | Intensity work hassles <i>slope, <math>\beta_{10}</math></i>   | 0.17                    | 0.07 | 2.44*   |
|                                 | Rigid control <i>slope, <math>\beta_{01}</math></i>            | -0.11                   | 0.04 | -2.85** |
|                                 | Rigid control*hassles <i>slope, <math>\beta_{11}</math></i>    | 0.07                    | 0.02 | 3.32**  |
| <i>Flexible control</i>         | Intensity work hassles <i>slope, <math>\beta_{10}</math></i>   | 0.18                    | 0.07 | 2.57*   |
|                                 | Flexible control <i>slope, <math>\beta_{01}</math></i>         | -0.05                   | 0.05 | -1.00   |
|                                 | Flexible control*hassles <i>slope, <math>\beta_{11}</math></i> | 0.07                    | 0.02 | 2.84**  |

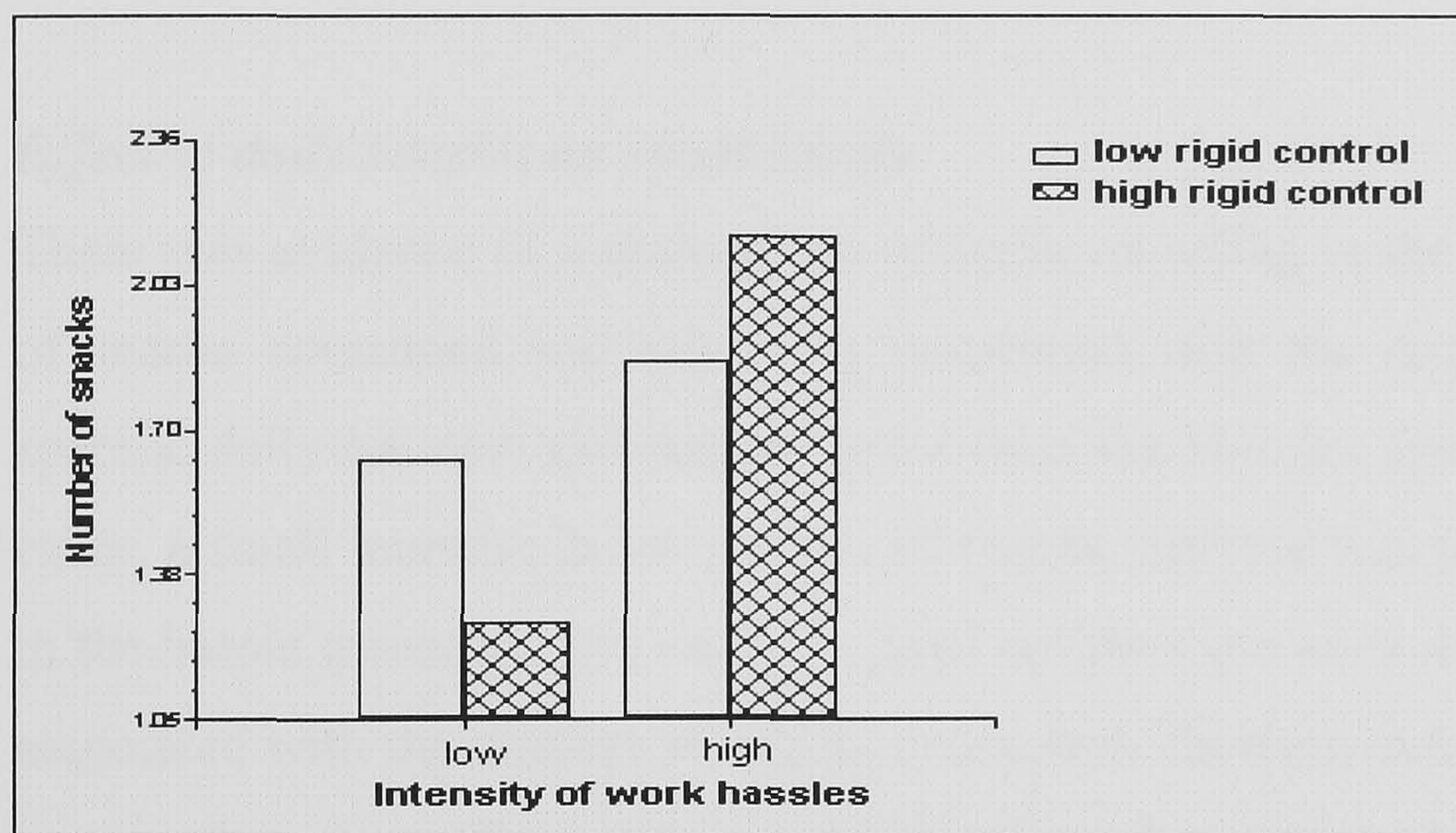
\* Significant at  $p < 0.05$

\*\*Significant at  $p < 0.01$

N.B. The coefficients in Table 2.12 are unstandardised.



Table 2.12 shows that the intensity of work-related hassles interacted with restraint ( $\beta=0.02$ ,  $t=2.73$ ,  $p<0.01$ ), rigid control ( $\beta=0.07$ ,  $t=3.32$ ,  $p<0.01$ ) and flexible control ( $\beta=0.07$ ,  $t=2.84$ ,  $p<0.01$ ) to relate to the number of snacks consumed. In all cases, the relationship between hassles and snacks increased as restraint increased. When all three of these restraint variables were entered simultaneously, only the interaction with rigid control remained significant ( $\beta=0.08$ ,  $t=2.24$ ,  $p<0.05$ ). Figure 2.5 shows the number of snacks consumed at low and high work hassle intensities for low and high rigid control groups.



**Figure 2.5 Interaction between work hassle intensity and rigid control score in predicting number of snacks consumed**

Figure 2.5 shows that at low intensities of work hassles, those high in rigid control consumed fewer snacks than those with low rigid control scores. However, with high intensities of work-related hassles, the high rigid control group consumed a greater number of snacks than those low in rigid control. While both groups showed an increase in snack consumption with the intensity of work hassles, the high rigid control group showed a much greater increase.

### 2.3.2.3 Summary of findings

Greater intensities and numbers of hassles were both associated with increased snack intake. External and emotional eating scores showed cross-level interactions with the number and intensity of hassles, so that high external eaters consumed a greater number of snacks with a low number of hassles and high emotional eaters consumed a greater number of snacks with low hassle intensities. Increases in the intensity of



health/body-related hassles were associated with increased intake, especially in high emotional eaters, high external eaters and high disinhibitors. Work hassles were associated with increased intake, especially in respondents high in rigid control.

### **2.3.3 Discussion**

Study Two aimed to investigate the relationship between daily hassles and intake in a sample of employed adults. Through the use of hierarchical linear modelling, the study aimed to test both the within-person and between-person associations between hassles and snack intake, using level one and level two predictors.

#### ***Effect of daily hassles on snack intake***

There was evidence of a main effect of stress on eating in the sample. The number of snacks consumed was positively associated with the number and intensity of specific daily hassles, and hassles score from the Hassles and Uplifts Scale. In all cases, a small increase in the number of snacks reported was found with an increase in the hassle measure. Interestingly, total uplifts score each day was also positively associated with the number of snacks consumed, showing that the number of snacks increased with uplifts score. Previous researchers have also found evidence of increased intake during positive moods (Patel & Schlundt, 2001). Therefore, it seems to be the case that uplifts and positive mood also prompt increased food consumption relative to a neutral mood, rather than producing the opposite effect to negative events.

#### ***Effect of hassle type on snacking***

The results of the current study showed that while the number and intensity of hassles overall was associated with increased intake, this relationship did not emerge for all hassle types. The intensities of person-related and feelings-related hassles were not significantly related to the number of snacks consumed. The person-related and feelings-related categories were designed to correspond with interpersonal and ego threatening stressor types, which have been previously associated with increased intake (e.g. Heatherton et al., 1991; Tanofsky-Kraff et al., 2000). Therefore it is unusual that the intensities of these hassle types were unrelated to snack consumption. However, it could be that testing environment affects the relationship between these hassle types and snack intake, since previous



positive associations between interpersonal and ego threatening hassles and snack intake have been shown in the laboratory rather than in the field.

However, the overall sample showed a positive association between the number of daily snacks consumed and the intensity of both health and body-related hassles and work-related hassles. This finding supports a previous report of increased food intake with work-related stress in the form of workload, in an employed sample (Wardle et al., 2000). The results are also greatly strengthened by those of O'Connor et al. (2005), who reported work-related hassles to be the strongest predictors of snack consumption in the only previous multilevel analysis of daily stress and snack intake. Study One did not find a relationship between work-related hassles and snack intake in a student sample; however, it seems plausible that work hassles are more salient for employed individuals than students, as work stressors are likely to be less transient for employees.

### ***Moderator effects***

When all hassles were considered, external eating style significantly interacted with the number of hassles, such that high external eaters consumed more snacks when there were fewer hassles. This is incongruent with Conner et al.'s (1999) finding of increased snack consumption with hassles in high external eaters. Similarly, emotional eating appeared to moderate the relationship between hassle intensity and snack intake, whereby high emotional eaters consumed fewer snacks with a greater hassle intensity, and low emotional eaters consumed a greater number of snacks with an increased hassle intensity. This finding also does not fit with previous research of increased consumption with stress in emotional eaters (e.g. Van Strien et al., 2000).

However, with health and body-related hassles specifically, external eating, disinhibition and emotional eating scores interacted with hassle intensity, so that high external eaters, disinhibitors and high emotional eaters consumed a greater number of snacks with increased hassle intensity. Therefore, the moderating effect of external and emotional eating differed according to hassle type, such that the results were more consistent with previous research for health and body related (physical) hassles. It is unclear why this pattern emerged for physical hassles

specifically, rather than ego threatening or interpersonal hassles. Since self-rated intense physical hassles frequently involved illness, it could be that the emotional and external eaters consumed more snacks to provide comfort, or as a result of absenteeism and a higher exposure to foods at home. In particular, external eaters would be expected to consume more if exposed to food cues. However, as there was no record of whether respondents were at home or work on these days this argument is speculative and cannot be tested. Another possibility is that health and body-related hassles involving physical sensations cause a high sense of self-awareness, driving the individual to reduce awareness of the self and increase awareness of the immediate environment, as escape theory proposes (Heatherton et al., 1992). A change in awareness may be expected to increase consumption in external eaters particularly, if food was present. This explanation does not entirely fit with the findings reported here, as escape theory would also predict an increase in food consumption with feelings-related hassles, which was not found in the current study. However, it would be interesting to test whether external eaters do show a shift in attention towards food and immediate stimuli when stressed.

There was evidence of a moderating role of dietary restraint in the relationship between daily hassles and snack intake. Flexible restraint score interacted with the number of daily hassles to predict the number of snacks, so that those high in flexible restraint consumed a greater number of snacks with an increased number of hassles. All three measures of restraint appeared to moderate the relationship between the intensity of work-related hassles and snack intake. DEBQ restraint, and both flexible and rigid restraint were also found to interact with work-related hassle intensity, such that those individuals high in restraint increased snack consumption with increased intensities of work-related hassles. This interaction was particularly strong for rigid restraint score. Westenhoefer et al. (1999) proposed that those high in rigid restraint are more susceptible to disinhibited eating, since their approach to dieting is much less flexible, with failures seen as more catastrophic for the diet. The results from the current study support a stronger association between work-related hassles and snack consumption in high rigid control restrained eaters than flexible control eaters, which supports this theory; however, the two constructs were very strongly correlated, which suggests that there may be more of a tendency to rigid or flexible control rather than a distinct typology.



It is not clear why restrained eaters were particularly susceptible to increased snack intake with intensity of work-related hassles, rather than hassles per se. One possible explanation relates to the cognitive load theory of stress-induced eating in restrained eaters (Boon et al, 2002). The demands of work-related stressors, including a high workload, may pose such a cognitive demand onto restrained eaters that they are distracted from monitoring their diet and consequently override its restrictions. This theory and the results of the current study fit with previous findings that restrained eaters are more susceptible to increased intake during highly demanding tasks (e.g. Lattimore & Caswell, 2004).

Personality did not appear to act as a moderator of the relationship between stress and eating in the current study. None of the personality variables was found to moderate the relationship between either the number or the intensity of hassles and snack intake. However, there were significant relationships between personality and eating style. Dietary restraint was significantly related to perfectionism and conscientiousness, and emotional stability was significantly negatively related to restraint, disinhibition and emotional eating. The significant relationship between perfectionism and restraint supports previous findings (Slade and Dewey, 1986). It is possible that certain personality characteristics predispose individuals to develop eating style, so that those high in perfectionism and conscientiousness have a tendency towards restrained eating, and those low in emotional stability have a tendency towards emotional eating and disinhibition.

### ***Strengths and limitations***

One disadvantage of diary studies is that they are time-consuming for the respondents to complete and require co-operation over a number of days, which may explain why the response rate was just over fifty per cent in this study. However, the nature of this particular study meant that the respondents recorded their hassles and snack intake over two weeks, rather than just over one day. The diary methodology therefore allows the relationship between hassles and intake to be measured more reliably over a longer period, rather than simply providing a 'snapshot' of the relationship between hassles and intake. The use of multilevel modelling in Study Two enabled the relationship between hassles and intake to be assessed within individuals over the fourteen days, so that individual changes in

intake to be observed. Despite the improved reliability and insight that multilevel modelling affords (Affleck et al., 1999), this technique has only previously been applied to the relationship between stress and food intake in one study (O'Connor et al., 2005).

### ***Conclusions***

Overall, the findings from the current study showed that there was an increase in snack consumption with an increased incidence of hassles across the whole sample. Further analysis revealed that this relationship was dependent on hassle type and eating style, such that work-related hassles were associated with increased snack intake in restrained eaters, which may be attributable to increased cognitive load and decreased dietary monitoring. Health and body-related hassles were strongly related to snack intake in external eaters, emotional eaters and high disinhibitors, which may have been due to increased self-awareness and subsequent change in attention, absenteeism and comfort eating.

### **2.4 General discussion**

Studies One and Two aimed to further explore the moderators of stress-induced eating to determine which variables were most important moderators of the relationship. Both studies also aimed to test whether intake response to stress would vary according to stressor type. In addition, Study One tested whether the intake response varied according to different snack types. Both studies adopted survey methodologies in answering these research questions, with a questionnaire employed in Study One and a diary methodology in Study Two. Although the two studies addressed the same research questions, they differed in the sampling populations and data collection periods. While Study One collected data from a student sample and required participants to recall their hassles and snack intake over one day, Study Two collected data from a smaller sample of employed individuals and required participants to record daily hassles and intake over fourteen days.

The results from both studies suggested that emotional eating style and gender were the strongest moderators of stress-induced eating. Study One reported that hyperphagic responses to stress were predicted by increasing emotional eating, and were more commonly reported by the female respondents. Furthermore, gender and



emotional eating style combined to predict snack intake, so that the consumption of sweets and chocolate snacks was predicted by increasing stress levels in female, high emotional eaters only. In Study Two, high emotional eaters showed a decrease in snack consumption with greater hassle intensities; however, high emotional eaters increased their snack intake as the intensity of physical hassles increased, suggesting that the moderating role of emotional eating is dependent on the type of stressor experienced. A similar pattern of results emerged for external eating style in Study Two, so that high external eaters decreased snack consumption as the number of hassles increased, but showed a stronger positive association between intensity of physical hassles and snack intake than low external eaters. Neither study supported a moderating role of personality. However, certain personality traits were associated with eating style characteristics so that perfectionism and conscientiousness were positively related to dietary restraint, and emotional stability was negatively related to restraint, disinhibition and emotional eating. This led to the conjecture that particular personality traits might predispose individuals to develop eating styles associated with susceptibility to stress-induced eating. Taken together, the results from Studies One and Two showed a greater susceptibility to stress-induced eating in females and emotional eaters, as is consistent with previous laboratory and field research (e.g. Grunberg & Straub, 1992; O'Connor et al., 2005; Van Strien et al., 2000).

The two studies together supported the notion that the relationship between stress and eating varies according to stressor type, although the effects of hassle type differed between the two populations. In particular, physical and work-related hassles showed interesting relationships with snack intake. Study One reported a negative association between physical hassles and the intake of sweets and chocolate snacks, while Study Two reported a positive association between physical hassles and intake within susceptible subgroups. Previous laboratory and field studies have shown a decrease in food consumption with physical stressors (Heatherton et al., 1991; O'Connor et al., 2005) as is consistent with the findings from Study One, and therefore it is difficult to explain why this was not replicated in Study Two. However, it may be significant that only those groups highly susceptible to stress-induced eating showed a positive association between the presence of physical hassles and snack intake in Study Two, rather than the sample as a whole.

Furthermore, the physical hassle category encompassed a wide range of hassles when coded by either the researcher or the respondent, which may have led to inconsistencies in the relationship with intake. Study Two also reported that the intensity of work-related hassles was positively related to snack intake, especially in respondents high in rigid control restraint, which is more consistent with previous research from the field (O'Connor et al., 2005; Wardle et al., 2000). Overall, the results from Studies One and Two suggest snack intake to be positively associated with work-related hassles, and negatively associated with physical hassles, except among subgroups highly vulnerable to stress-induced eating.

Study One addressed whether stress had differential effects on the intake of different snack types. The results showed a positive association between the intake of crisps and nuts with stress ratings, especially in females. This finding fits well with the conjecture that crunchy foods are preferred during times of stress, as the biting action serves to relieve stress (Willenbring et al., 1986). This finding is also supported by previous research showing an association between stress and the intake of crisps (Shapiro & Anderson, 2005).

Overall, the results from both studies suggest that emotional eating and gender were the strongest moderators of the relationship between stress and eating, such that increased snack intake is greater among females and high emotional eaters. The type of stress experienced also appeared to influence the stress-eating relationship, so that work-related and physical hassles showed associations with snack intake. The intake of crunchy foods increased with stress, suggesting a preference for this snack type when stressed. In addition, female, emotional eaters increased consumption of sweets and chocolate snacks with greater stress levels.



## CHAPTER THREE

### INVESTIGATING AN ATTENTIONAL SHIFT MECHANISM FOR STRESS-INDUCED EATING

#### 3.1 Introduction

Studies One and Two in Chapter Two focused on the moderators of stress-induced eating, and highlighted moderating roles for gender, emotional eating style and restraint. Relatively little is known about the underlying mechanisms of stress-induced eating, or why certain subgroups are more susceptible than others. However, one possibility is that there is a change in attentional processes during stress, whereby susceptible individuals attend towards food stimuli more when stressed. Slochower (1976) has theorised that individuals increase their awareness of the immediate environment when stressed, including food-related stimuli. Extending this, 'escape theory' (Heatherton & Baumeister, 1991) proposes that individuals are motivated to turn their attention away from stressful stimuli and towards the immediate environment, to reduce awareness of both noxious stimuli and oneself. Since decreased self-awareness is the main motivation behind an attentional shift, it has been suggested that ego-threatening stressors would be especially associated with attentional changes (Wallis & Hetherington, 2004). Such a theory could explain increased intake under stress in highly restrained individuals, as the decreased awareness of the self and situation would enable the usual dietary restrictions to be abandoned. In external eaters, a shift in attention towards the environment during stress would promote increased intake if food were present, as this would serve as an eating cue to highly external individuals.

In investigating attentional biases, two major paradigms have dominated research. In a modified version of the Stroop colour-naming task (Stroop, 1935), the time taken to name the ink colours of emotionally salient and control words is recorded. A slower colour-naming response time for salient words is indicative of a greater interference in the processing of the word's meaning, i.e. an attentional bias towards that word. The main alternative to the modified Stroop test is the dot probe task (Posner et al., 1980). In the dot probe, the participant is required to respond to the location of a 'probe' (e.g. a dot or an arrow) immediately after the simultaneous

presentation of a target and a control word. Here a faster response time when the probe appears in the same location as the target word is indicative of an attentional bias towards the target word. Attentional biases towards salient information have been consistently reported within the field of anxiety disorders (e.g. MacLeod et al., 2002; Matthews & MacLeod, 1985), and addiction (e.g. Boyer & Dickerson, 2003; Waters et al., 2003). More recently, the attentional bias paradigm has also been employed in studies of eating disorders and behaviours.

Biases towards food, shape and weight words have previously been investigated in eating disordered samples, and have yielded mixed outcomes. Jones-Chester et al. (1998) reported that eating disordered patients (both anorexics and bulimics) were slower to colour name food-related and weight or shape words compared with neutral words in a modified Stroop test. In support of these findings, Rieger et al. (1998) found that anorexics and bulimics showed attentional biases towards negative body shape words and away from positive body shape words, in a dot probe task. In two other studies, bulimics and anorexics have been found to be significantly slower in colour-naming body size and shape words, but not food words, compared with non-patients (Davidson & Wright, 2002; Sackville et al., 1998). Overall, attentional biases have been found consistently in eating disordered populations, but are more convincing for body-related than food-related stimuli.

Within non-clinical samples, attentional biases for food and shape/weight words have been investigated in restrained individuals, but effects have been less consistent. Francis et al. (1997) reported that highly restrained individuals took longer to respond to food words than neutral words in a modified Stroop test. Similarly, Stewart and Samoluk (1997) found that highly restrained participants were slower to respond to dietary forbidden food words compared with control words, in a card version of the Stroop task. However, Jansen et al. (1998) found no evidence of slower processing of body shape and weight words in restrained individuals. Similarly, Sackville et al. (1998) found no difference in the processing of body shape/weight words or high calorie food words between restrained and unrestrained eaters and Lattimore et al. (2000) found no difference in processing of food words between restrained and unrestrained adolescents. While results have



been mixed, the significant effects indicate a bias for food-related stimuli, rather than body-related, in contrast to the eating disorder research.

Research has concentrated on attentional biases in restrained eaters but has not explored biases in other populations to the same extent. To date, one study has investigated biases for food stimuli in external eaters (Johansson et al., 2004). The external eaters showed a bias away from food words in a dot probe task, while no effects were found with the Stroop paradigm. This finding in the dot probe task is counterintuitive. Externality theory (Schachter et al., 1968) proposed that external eaters use external cues, including the sight of food, to control intake. Since external eaters have a greater reliance on these food cues than non-external eaters, they may also be expected to attend towards these cues to a greater extent than non-external eaters, the opposite of Johansson et al.'s finding.

However, Johansson et al.'s (2004) study did not examine attentional biases when in a stressed or anxious condition. Similarly, attentional biases have not been tested in restrained eaters under conditions of stress. Since both external eaters and restrained eaters are more likely to increase their food intake under conditions of stress (Conner et al., 1999; Herman & Mack, 1975), it seems plausible that attentional biases towards food stimuli would be more prevalent when stressed. In an extension of escape theory, attentional biases may exist towards food stimuli specifically rather than all stimuli in the immediate environment. Escape theory also predicts an attentional bias away from the stressor. While food biases have not yet been tested, there is evidence of a bias away from negative stimuli during stress (Ellenbogen et al., 2002). Whether this attentional shift away from stressful stimuli is more prominent in groups susceptible to stress-induced eating has not yet been tested, though this would be a logical additional effect of an increased bias for food-related information.

Very few studies have tested whether attentional biases for food are dependent on the type of food stimuli presented. Cognitive biases for forbidden food words have been shown in restrained eaters (Israeli & Stewart, 2001), but Sackville et al. (1998) reported no difference in bias for high or low calorie foods in restrained eaters. The stress and eating literature points towards an increase in unhealthy food

consumption during stress (e.g. Oliver et al., 2000; Oliver & Wardle, 1999), and snack intake is especially susceptible to stress-related changes in intake, as Conner et al. (1999) and the results from Study One suggest. Since no studies have examined attentional biases for food stimuli during stress, there are no reports as to the types of food stimuli that are particularly attended to during stress. However, if attentional biases are responsible for increased food intake, this leads to speculations that biases would be particularly strong for unhealthy and snack foods.

Attentional biases are dependent on a number of methodological factors, including the type of task employed to measure bias. Experiments frequently use a modified Stroop colour-naming task, especially eating-related studies. However, the Stroop task is criticised as a measure of attentional bias, as it is argued that longer response latencies could result from an attentional bias either towards or away from the stimuli. The dot probe task has been adapted for studies of attentional bias to address this criticism (MacLeod et al., 1986). Since target and neutral stimuli are presented simultaneously in the dot probe, the direction of attentional bias can be more easily determined. It is also argued that computerised dot probe and Stroop programs are preferable, to avoid demand characteristics and experimenter expectancy effects (Davidson & Wright, 2002).

Another important consideration in testing attentional biases for food stimuli is that they may be dependent on current hunger state. Mogg et al. (1998) found that fasted individuals had a greater bias towards food-related words than did non-fasted individuals in a dot probe task. Hunger may also interact with eating style factors. Placanica et al. (2002) used a dot probe paradigm to study the effect of hunger and disordered eating attitudes on attention to food and shape/weight words. Attention towards high-calorie food increased with hunger in participants both with and without disordered eating attitudes. Furthermore, those with disordered attitudes showed a greater attentional bias to low calorie foods when fasted than those without disordered eating attitudes, showing that attentional shifts for food during hunger differed according to disordered eating subgroup. Consequently, it seems that hunger plays a main and possible interactive role in attention towards food-related information, and therefore the effect of hunger needs to be controlled within Stroop and dot probe research designs involving food words.



The main aims of Studies Three, Four and Five were to investigate whether vulnerable eating style subgroups show attentional biases towards food stimuli when stressed and to test whether any observed biases were dependent on the type of food stimuli. An interaction between stress and eating style for bias scores was predicted, so that restrained and external eaters under stress conditions would show the greatest bias scores for food stimuli. It was further predicted that bias scores would be greatest for unhealthy and snack food stimuli.

### **3.2 Study Three: Attentional biases for food words in external eaters, using computerised Stroop and dot probe**

Study Three aimed to investigate whether high external eaters show an attentional bias towards food stimuli when stressed, and whether attentional biases for food differ according to the type of food presented. It was hypothesised that there would be an interaction between external eating style and stress, where the greatest bias scores would occur for external eaters in a stressful condition, and that bias scores would be greatest for unhealthy and snack words. The study also aimed to test whether dietary restraint would interact with stress to affect attentional biases, with the prediction that highly restrained individuals would show an increased bias for food words under stress compared with low restrained individuals. It was finally hypothesised that stressed participants would demonstrate an attentional avoidance of threatening stimuli. Each participant was only ever exposed to the stressor or the control condition to prevent practice and order effects with the word trials, and therefore the study had a between subjects design. However, participants were exposed to all the word trials within the dot probe and Stroop tasks so that bias scores could be calculated, and so there was a within-subjects component to the design.

#### **3.2.1 Method**

##### ***Participants***

The participants in this experiment were selected from the questionnaire sample in Study One according to their score on the external eating subscale of the Dutch Eating Behaviour Questionnaire. Those scoring within the top or bottom twenty per cent (i.e. scores  $<27$  and  $>37$  for the high and low external eating scores

respectively) were asked via email to participate in the current study. In total, 126 respondents were contacted, and 69 took part (response rate=55%). Of the 69 participants, 32 were classed as low external eaters and 37 as high external eaters. The sample included 27 males and 42 females, with the numbers of males and females matched in the stress and control conditions. Age ranged from 18 to 59 years (mean age of 21.80 years). All the participants spoke English as a first language. Participants were paid five pounds for taking part, and also offered the chance to win fifty pounds in a prize draw. The ethics approval for Studies Three, Four and Five is shown in Appendix 3.1.

### ***Measures***

The Dutch Eating Behaviour Questionnaire (DEBQ; Van Strien et al., 1986a) was pre-administered in Study One to measure dietary restraint and external eating, with the external eating scale used to select participants. The participants were administered with the shortened version of the Spielberger State-Trait Anxiety Inventory (Marteau & Bekker, 1992) before and after the control or stress manipulation. This shortened version of the scale has been shown to be comparable to the full version (Marteau & Bekker, 1992). Participants rated their hunger prior to the experiment using a seven-point anchored scale from ‘not at all hungry’ to ‘extremely hungry’. An anchored scale was chosen over a visual analogue scale for ease of completion by participants.

### ***Materials***

The Stroop stimulus words were divided into four initial categories. These were unhealthy foods (e.g. cheese, shortcake), healthy foods (e.g. cereal, pineapple), ego threatening words (e.g. lonely, worthless), and neutral words (e.g. jersey, batteries), with twenty-five words in each category (see Appendix 3.2). Ego threatening words were chosen to match the nature of the stressor, and many ego threatening and control words were based on those used by MacLeod et al. (2002). Words were validated as ego-threatening or control words according to threat ratings from an independent panel, with a significant difference in threat ratings found between the two categories in the expected direction ( $t(7)=15.05$ ,  $p<0.0005$ ). The unhealthy and healthy words were validated according to ratings of fat and sugar content from the same panel. A significant difference was found between ratings, where unhealthy



words were rated as much higher in fat and sugar ( $t(7)=7.00$ ,  $p<0.0005$ ). The words between categories were matched as far as possible for word length and frequency using ratings from Thorndike and Logue (1944) and Leech et al. (2001).

There were three main categories of words in the dot probe task: 25 healthy food words, 25 unhealthy food words, and 50 neutral words. In each word pair, a food word was matched with a control word, with the words in each pair matched for frequency and length as far as possible (see Appendix 3.3). The same words were used in the dot probe as in the Stroop task, with an additional 25 neutral words.

Food words were also categorised as snack or meal food words by asking an independent panel of raters to indicate which foods were snacks, which were more commonly eaten as part of a meal and which could be eaten as either. Food words that were considered by the majority of raters as a snack or meal word were categorised as such, but foods that were considered to be both a snack and meal food were not categorised as either. This meant that there were fifteen snack words (e.g. crisps, chocolate) and twenty-three meal food words (e.g. chicken, cauliflower).

### ***Stroop and dot probe programs***

Both the modified Stroop and dot probe tasks were computer-based, with a screen size of 8 by 11 inches. For the Stroop task, a microphone was attached to the computer and placed in front of the participant to record vocal response times. The words were presented individually in one of four colours (red, green, yellow or blue) on a black background until a vocal response was recorded, or for a maximum of 3000ms (procedure based on Davidson & Wright, 2002; Smith & Waterman, 2005). The words appeared in randomised order and randomised colours, for a total of 100 trials, with a 1000ms pause between each word. The experimenter coded responses as correct, incorrect or invalid (e.g. no sound recorded by the microphone) using the 'a' 's' and 'd' keyboard keys after each trial (c.f. Smith & Waterman, 2005).

In the dot probe task, 50 word pairs were presented to each participant, in a randomised order. In each trial, a word pair was presented on the screen for 500ms, with one word in the upper half of the screen and the other word in the lower half of the screen. In half the trials, the target food word was presented in the upper half of

the screen, and in the other half food words were presented in the lower half of the screen. A blank screen was shown for 16.7ms, before a dot appeared in the position of one of the words for a further 500ms (procedure based on Smith & Waterman, 2004). The dot appeared randomly in the top or bottom of the screen. A two-button keypad (with buttons labelled 'top' and 'bottom') was attached to the computer, and participants were asked to respond to the dot's location by pressing the corresponding button on the keypad, with a maximum of 3000ms in which to make a response. An 'X' appeared for 500ms before each trial to keep the participant's focus directed at the centre of the screen. The computer recorded the times taken to respond to the dot's location in each trial. There were four practice trials at the start of both the modified Stroop and dot probe tasks so that participants fully understood the requirements.

### ***Stress induction protocol and control procedure***

After providing written consent, participants in the stress condition were given a sheet of instructions with a list of nine controversial topics, including 'abortion' and 'cannabis legalisation' (see Appendix 3.4). The instructions informed participants that they would be given ten minutes in which to prepare a speech about their own attitudes towards one of the topics, of their own choosing (paper and a pen were provided for this task). They were informed that the speech should last approximately four minutes, and would be video-recorded and performed live to a group of psychologists who were watching through a two-way mirror. The participants were led to believe that this speech would be performed after the two computer tasks. However, after completion of the Stroop and dot probe tests, they were informed that they would not be asked to perform the speech at all. This stress procedure was partially based on the stress-induction procedure used by Oliver et al. (2000), and was designed to induce anticipatory stress to an ego-threatening stressor. The participants in the control spent ten minutes circling every 't' in an extract from Dr. Seuss's 'The Cat in the Hat', with no pressure to reach the end of the text. The control task was adapted from Tanofsky-Kraff et al. (2000).

### ***Procedure***

Questionnaire respondents with external eating scores in the top or bottom twenty per cent were contacted by email and asked to take part in a further study looking at



‘mood and performance’. Each participant was tested individually in the laboratory. On arrival, the participant was given a study information sheet outlining the study procedure. The information was identical for the control and experimental conditions, except that the controls were informed that they would be asked to perform a pen and paper task for ten minutes, and the experimental group were informed that they would be asked to prepare a presentation for ten minutes. The participants were then required to complete both the state anxiety measure and hunger scale. Those participants in the stress condition completed the stress-induction procedure, while the control participants underwent the control procedure. A second measure of state anxiety was taken following both the stress and control tasks. Participants completed the modified Stroop and dot probe tasks in a predetermined, counterbalanced order. The instructions for both tasks appeared on the screen, and asked participants to respond as accurately and quickly as possible in each trial. The participants were left alone to complete the dot probe task, but the experimenter was present during the Stroop to code correct and incorrect responses. After the completion of the computer tasks, the stress group were informed that they would not be asked to perform the presentation. The participants were paid five pounds after completing the study and given a full debrief.

### ***Statistical analysis***

Bias scores were calculated in both the Stroop and dot probe tasks for the food words (overall food, healthy, unhealthy, snack and meal food words), and for ego threat words in the Stroop task (refer to sections 3.2.2.1 and 3.2.2.2 for calculation procedures). Interactions between external eating and stress for bias scores were tested using ANCOVA and MANCOVA, with hunger added as a covariate. The effect of restraint and its interaction with stress on food bias scores was tested by dividing the sample into high and low restraint groups based on a median split, and conducting ANCOVA and MANCOVA with bias scores as dependent variables. Finally, the correlations between the bias scores for Stroop and dot probe were calculated using Pearson’s Coefficients.

### 3.2.2 Results

#### *Scale Reliabilities*

The subscales of the DEBQ were found to show good internal reliability with high Cronbach's alpha values (restraint=0.94; external eating=0.92).

#### *Stress manipulation check*

Before the stress manipulation, the stress and control groups had similar scores on the state anxiety measure, with a mean of 10.26 (2.25) for the stress group and 9.26 (2.55) for the control group. An independent groups t-test showed that there was no difference between the groups in state anxiety before the manipulation ( $t(67)=1.79$ , n.s.). After the manipulation, the stress group had an increased mean anxiety score of 14.00 (2.99), while the control group showed a small increase to 9.91 (2.38). The stress and control groups showed a significant difference in STAI score after the manipulation ( $t(67)=5.77$ ,  $p<0.001$ ), with greater state anxiety scores in the stress condition. Furthermore, a paired t-test with the dependent variable of anxiety score and the independent variable of measurement time showed that there was a significant increase in anxiety in the stress group ( $t(33)=-7.42$ ,  $p<0.01$ ) but not in the control group ( $t(34)=-1.97$ , n.s.). Therefore the stress manipulation appeared successful in increasing anxiety levels. To check that both high and low external eaters responded in the same way to the stress manipulation, an independent t-test was conducted with a dependent variable of post manipulation anxiety score and independent variable of external eating group. This was found to be non-significant ( $t(67)=-1.57$ , n.s.), indicating no differences in response between the two groups.

#### 3.2.2.1 Stroop analysis

##### *Data treatment*

Incorrect responses and outliers in response times were not included in analysis, using the procedure of Mogg et al. (2000). Outliers in the response times were determined using box and whisker plots. Times smaller than 300ms and greater than 900ms were excluded. This led to the removal of 3% of the response times due to errors, and 5% due to outliers. Bias scores for the ego threatening words and different food types were calculated as a more reliable measure of attentional bias with respect to response times for neutral words. These were calculated by



subtracting the mean response times for neutral words away from the mean response times for each of the types of food target words. A positive bias score therefore indicated an attentional bias towards that particular word type. Box and whisker plots of the overall bias scores identified two outlier cases, so these were removed from analysis. A further case was removed because the microphone had not detected a large number of vocal responses, leaving an N of 66.

### ***Bias scores***

The mean bias scores and standard deviations for each of the four conditions (high and low external eaters, high and low stress condition) are shown in Table 3.1.

### ***Ego threat bias***

Table 3.1 shows that the mean ego threat biases were negative for three of the four groups (i.e. showed an attentional avoidance). The high external eaters had a negative bias in both stress and control conditions, but the low external eaters only had a negative bias in the stress condition. Two-way ANOVA with independent variables of external eating group and stress condition revealed no significant effects of stress condition ( $F(1,62)=0.02$ , n.s.) or eating group ( $F(1,62)=0.19$ , n.s.) nor an interaction between external eating and stress ( $F(1,62)=0.16$ , n.s.).

**Table 3.1 Mean bias scores (ms) in modified Stroop task for high and low external eaters in stress and control conditions (N=66)**

|                | Mean bias (SD)              |                            |                              |                             |
|----------------|-----------------------------|----------------------------|------------------------------|-----------------------------|
|                | Low external control (N=14) | Low external stress (N=16) | High external control (N=19) | High external stress (N=17) |
| Ego threat     | 2.91 ( $\pm 25.10$ )        | -0.22 ( $\pm 23.46$ )      | -2.10 ( $\pm 26.46$ )        | -0.49 ( $\pm 23.87$ )       |
| Overall food   | 20.73 ( $\pm 20.39$ )       | 2.25 ( $\pm 18.53$ )       | 7.63 ( $\pm 21.02$ )         | 7.41 ( $\pm 17.28$ )        |
| Unhealthy food | 17.20 ( $\pm 22.74$ )       | 2.55 ( $\pm 23.72$ )       | 3.14 ( $\pm 21.71$ )         | 5.95 ( $\pm 20.17$ )        |
| Healthy food   | 24.18 ( $\pm 23.84$ )       | 2.03 ( $\pm 26.61$ )       | 12.04 ( $\pm 30.09$ )        | 8.58 ( $\pm 19.60$ )        |
| Meal foods     | 25.38 ( $\pm 21.59$ )       | 3.15 ( $\pm 25.47$ )       | 14.07 ( $\pm 26.55$ )        | 4.25 ( $\pm 20.11$ )        |
| Snack foods    | 20.19 ( $\pm 27.63$ )       | 0.77 ( $\pm 36.54$ )       | -1.64 ( $\pm 32.87$ )        | 10.08 ( $\pm 25.07$ )       |
| Hunger         | 3.07 ( $\pm 1.82$ )         | 3.38 ( $\pm 1.78$ )        | 3.21 ( $\pm 1.75$ )          | 3.47 ( $\pm 1.81$ )         |

### ***Overall food bias***

Table 3.1 shows that all four groups had a positive bias for the food words. The greatest food bias was within the low external eaters in the control condition (mean bias=20.73ms). Both high and low external eaters had a greater bias within the control condition; however, this difference was much more exaggerated within the low external eating group. To test the effects of stress condition and eating group, ANCOVA was conducted with food bias score as the dependent variable, stress condition and external eating as independent variables and hunger as a covariate. This revealed a marginally significant interaction between external eating and stress ( $F(1,61)=3.56$ ,  $p=0.06$ ), which was likely due to the large difference in bias scores between high and low external eaters within the control condition. There was no main effect of external eating group ( $F(1,61)=0.65$ , n.s.), but there was a marginal effect of stress on bias to food words ( $F(1,62)=3.79$ ,  $p=0.06$ ), demonstrating that there was a greater bias for food words within the control condition.

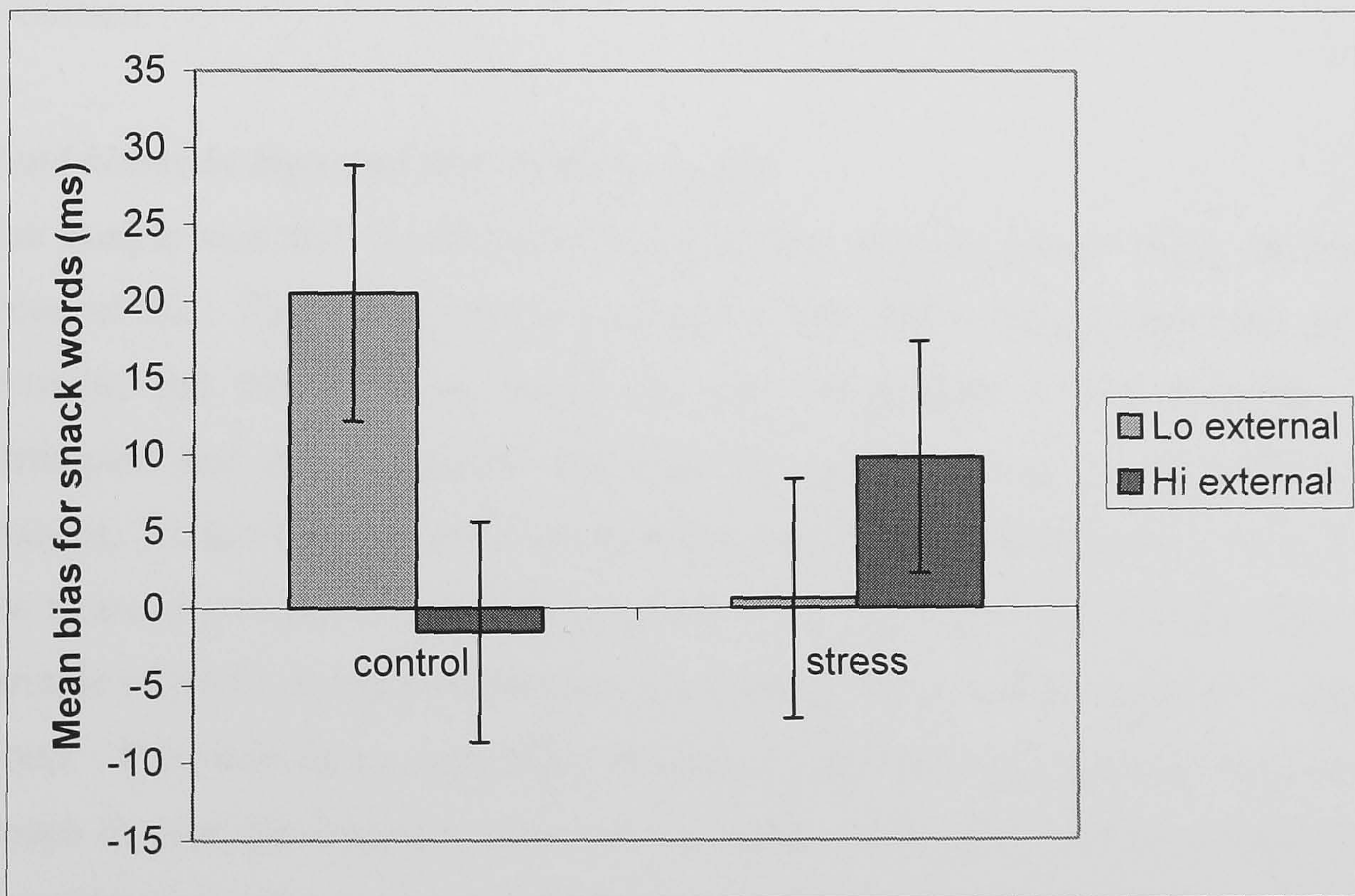
### ***Healthy and unhealthy food biases***

Table 3.1 shows that all groups had positive biases towards both healthy and unhealthy food words. The high and low external eaters had greater bias scores for healthy food words in the control condition than in the stress condition, but this difference was greater for the low external eaters (mean bias score of 24.18 in the control condition, and of 2.03 in the stress condition). For the unhealthy food words, the low external eaters had a greater bias in the control condition than in the stress condition. In contrast, the high external eaters had a slightly greater bias for unhealthy food words in the stress condition. To test for the effects of stress and external eating on bias for both healthy and unhealthy food words, MANCOVA was conducted with dependent variables of healthy and unhealthy food bias scores, independent variables of stress and external eating group, and a covariate of hunger rating. There was no significant interaction between stress and external eating for unhealthy food word bias ( $F(1,61)=2.52$ , n.s.) or healthy food word bias ( $F(1,61)=2.15$ , n.s.). There were also no main effects of stress or external eating group for either unhealthy or healthy food bias scores (all n.s.).



### *Meal and snack word biases*

The biases for meals and snack words were positive in all cases, except for a negative bias for snack words within the external control group. Table 3.1 shows that bias scores for meal words were greater in the control condition than the stress condition, for both high and low external eaters. The low external eaters showed this same pattern for the snack word biases, but high external eaters had a greater mean bias score in the stress rather than control condition for snack foods (mean bias score of 10.08 in stress condition, and mean bias score of -1.64 in control condition). To test the effects of external eating and stress on bias scores for both meal and snack food words, MANCOVA was conducted with stress and external eating as independent factors, meal and snack biases as dependent variables, and hunger rating as a covariate. This revealed a significant interaction between external eating and stress for the snack word bias scores ( $F(1,61)=4.10, p<0.05$ ), but not for meal word bias scores ( $F(1,61)=1.12, n.s.$ ). Figure 3.1 shows this interaction between stress and external eating.



**Figure 3.1** Snack food word bias scores for internal and external eaters in stress and control conditions (error bars represent standard error)

Figure 3.1 shows that in the stress condition, high external eaters had a greater bias than low external eaters for snack food words. However, in the control condition, the low external eaters had a much greater bias for snack words than did the high



external eaters, who had a slight negative bias score in this condition. Post-hoc univariate ANCOVA was conducted to test the interaction further, with hunger included as a covariate. This revealed no significant differences between the stress and control bias scores in the high external eating group ( $F(1,33)=1.27$ , n.s.) or within the low external eating group ( $F(1,27)=2.59$ , n.s.). There was also no significant difference between the bias scores for high and low external eaters in the stress condition ( $F(1,30)=0.69$ , n.s.). However, there was a marginal significant difference between the high and low external eaters in the control condition ( $F(1,30)=3.98$ ,  $p=0.06$ ), which was due to the high bias scores for the low external eaters in the control condition.

There was no main effect of external eating for meal or snack words (both n.s.). Stress condition did not have a main effect on snack word bias, but did have a significant effect on meal word bias ( $F(1,61)=6.87$ ,  $p<0.05$ ), showing that there was a significantly greater bias for meal words in the control condition than in the stress condition.

### ***Food biases in high and low restraint groups***

The sample was also divided into high and low restraint groups using the median value of 20. Those participants scoring 20 and above were categorised as high restraint, and those scoring below 20 were categorised as low restraint. One participant had not completed the restraint scale and was not included in the analysis. To test that the stress manipulation had comparable effects on the high and low restraint groups, an independent groups t-test was conducted with the dependent variable of post manipulation anxiety score and an independent variable of restraint group. This showed no significant differences between the high and low restraint groups in post manipulation state anxiety ( $t(66)=-1.04$ , n.s.). Table 3.2 shows the mean bias scores for food words in the stress and control conditions.



**Table 3.2 Mean bias scores (ms) in modified Stroop task for high and low restrained eaters in the stress and control conditions (N=65)**

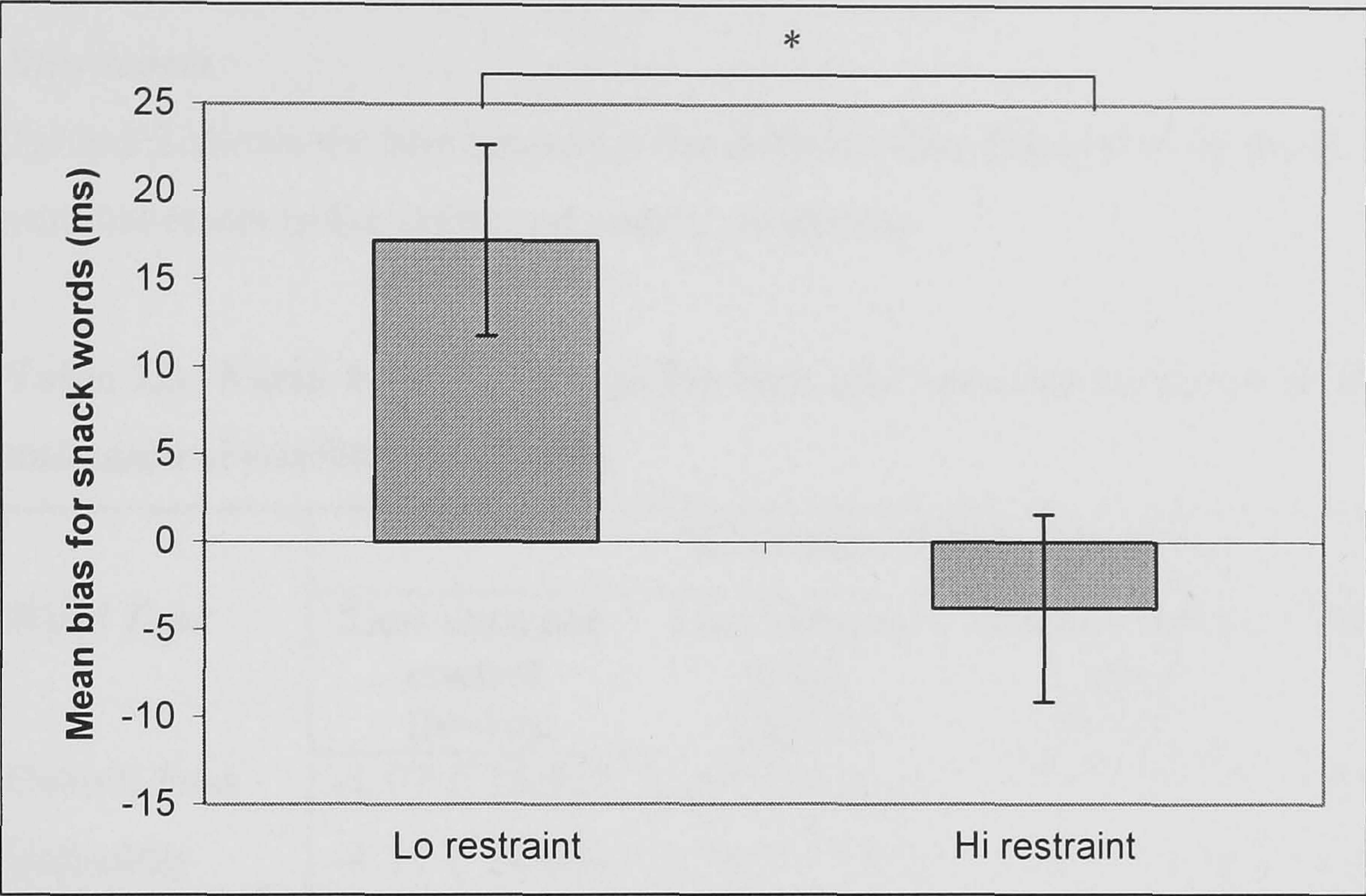
|                | Mean bias (SD)               |                             |                               |                              |
|----------------|------------------------------|-----------------------------|-------------------------------|------------------------------|
|                | Low restraint control (N=15) | Low restraint stress (N=17) | High restraint control (N=18) | High restraint stress (N=15) |
| Overall food   | 16.91 ( $\pm 25.23$ )        | 9.75 ( $\pm 16.44$ )        | 10.08 ( $\pm 17.89$ )         | -1.16 ( $\pm 18.50$ )        |
| Unhealthy food | 16.10 ( $\pm 27.90$ )        | 9.34 ( $\pm 20.56$ )        | 3.29 ( $\pm 16.36$ )          | -3.54 ( $\pm 20.54$ )        |
| Healthy food   | 17.78 ( $\pm 28.35$ )        | 10.06 ( $\pm 17.11$ )       | 16.69 ( $\pm 28.30$ )         | 1.06 ( $\pm 28.77$ )         |
| Meal foods     | 19.02 ( $\pm 23.39$ )        | 1.04 ( $\pm 16.89$ )        | 18.74 ( $\pm 26.70$ )         | 3.64 ( $\pm 25.82$ )         |
| Snack foods    | 16.42 ( $\pm 33.64$ )        | 18.53 ( $\pm 35.41$ )       | 0.29 ( $\pm 29.94$ )          | -8.27 ( $\pm 18.59$ )        |
| Hunger         | 3.87 ( $\pm 1.73$ )          | 3.35 ( $\pm 1.66$ )         | 2.56 ( $\pm 1.58$ )           | 3.47 ( $\pm 2.00$ )          |

Table 3.2 shows that high restraint participants in the stress and control groups had lower mean bias scores for food words overall than their low restraint counterparts. For the different types of food words, the low restraint group had a greater positive bias score than the high restraint participants in most cases, with the exception of meal food words in the stress condition. To test the effect of restraint and its interaction with stress, ANCOVA was conducted, with the dependent variable of bias for food words, the independent variables of restraint group and stress, and hunger as a covariate. There was no significant interaction between the two independent factors ( $F(1,60)=0.06$ , n.s.), but there was a marginally significant effect of restraint ( $F(1,60)=3.71$ ,  $p=0.06$ ), indicating that the low restraint group had a greater bias for food words.

To test the interaction effect between stress and restraint on bias for unhealthy and healthy food words, MANCOVA was conducted with unhealthy and healthy food bias scores as dependent variables, stress condition and restraint group as independent variables and hunger as a covariate. This revealed no interaction between stress and restraint for either outcome variable (both n.s.). However, there was a main effect of restraint group for unhealthy food word bias ( $F(1,60)=6.68$ ,  $p<0.05$ ), showing that there was a greater bias for unhealthy food words in the low restraint group. MANCOVA was also conducted with meal and snack bias scores as dependent variables. There was no interaction effect between restraint and stress for



either meal or snack words (both n.s.). However, there was a main effect of restraint for bias towards snack words ( $F(1,60)=7.42, p<0.01$ ), as Figure 3.2 shows.



**Figure 3.2 Bias for snack food words in high and low restrained eaters**

Figure 3.2 shows that the significant effect of restraint is due to a larger bias index for snack food words in the low restraint group. It is also apparent from Figure 3.2 that the high restraint individuals had a slightly negative bias for snack food words, while the low restraint individuals attended towards snack words.

**3.2.2.2 Dot Probe Analysis**

*Treatment of dot probe data*

All incorrect responses were removed from the analysis. This led to the removal of 1.6% of the response times. Box and whisker plots were used to determine outliers, and response times smaller than 200ms and greater than 600ms were excluded. This led to the removal of 3.5% of the response times. One case was removed at this point due to a large number of outliers in response times. Bias scores for the different categories of food words were calculated by subtracting the mean response time for target words from the mean response time for neutral words. This meant that a positive bias score indicated an attentional bias towards the target words, and a negative score indicated a bias away from the target words. Box and whisker plots



were again used to determine any outlying cases in the bias scores. This led to the removal of four further cases, leaving a total N of 64.

### ***Bias scores***

Table 3.3 shows the bias scores for the different food categories for the high and low external eaters in the stress and control conditions.

**Table 3.3 Mean bias scores (ms) for high and low external eaters in the stress and control conditions (N=64)**

| <i>Word Type</i> | Mean bias (SD) to 2dp in ms    |                               |                                 |                                |
|------------------|--------------------------------|-------------------------------|---------------------------------|--------------------------------|
|                  | Low external control<br>(N=14) | Low external stress<br>(N=16) | High external control<br>(N=17) | High external stress<br>(N=17) |
| Overall food     | -1.07 ( $\pm 15.95$ )          | 2.61 ( $\pm 16.74$ )          | -0.98 ( $\pm 14.74$ )           | -0.78 ( $\pm 12.99$ )          |
| Unhealthy food   | -4.11 ( $\pm 24.62$ )          | 2.34 ( $\pm 19.65$ )          | 2.43 ( $\pm 20.18$ )            | -0.01 ( $\pm 21.64$ )          |
| Healthy food     | 2.99 ( $\pm 22.35$ )           | 3.37 ( $\pm 22.41$ )          | -5.17 ( $\pm 17.46$ )           | -3.01 ( $\pm 16.15$ )          |

### ***Overall food biases***

The high external eaters had slightly negative bias scores for the food words overall (i.e. an attentional avoidance) in both the stress and control conditions. The low external eaters also had a negative mean bias for food words in the control condition, but showed a small positive bias in the stress condition. ANCOVA was conducted with the dependent variable of food word bias, the independent variables of stress condition and restraint, with hunger as a covariate. This revealed no significant interaction between stress and external eating ( $F(1,59)=0.23$ , n.s.). There were also no significant main effects of external eating ( $F(1,59)=0.15$ , n.s.) or stress ( $F(1,59)=0.26$ , n.s.).

### ***Unhealthy and healthy food biases***

Table 3.3 shows that for the unhealthy food biases, the low external eaters had a positive bias in the stress condition and a negative bias in the control condition. The high external eaters showed the opposite pattern, with a positive bias for unhealthy food words in the control condition, and a slight negative bias in the stress condition. Biases for healthy food words showed a slightly different pattern. High external

eaters had negative biases for healthy food words in both stress and control conditions, and low external eaters had positive bias scores in both conditions. However, all bias scores were very close to zero. To test the interaction between external eating and stress condition for healthy and unhealthy food word biases, MANCOVA was conducted with the two food bias scores as dependent variables, stress condition and external eating group as independent variables, and hunger as a covariate. This revealed no significant interaction between the two independent factors for either word type, and no main effects of either external eating or stress condition for either unhealthy or healthy food word bias scores (all n.s.).

### ***Food biases in high and low restraint groups***

As with the Stroop data, the effect of restraint and its interaction with stress on food bias scores was tested. The sample was divided into high and low restraint groups using the median value, so that those with scores below 20 were categorised as low restraint individuals, and those with scores of 20 and above were categorised as highly restrained. High and low restraint groups showed food biases close to zero (mean bias=-0.34 for low restraint and mean bias=0.44 for high restraint). ANCOVA was conducted with bias for food words as the dependent variable, restraint and stress condition as independent variables, and hunger as a covariate. No significant interaction emerged between restraint and stress ( $F(1,58)=0.19$ , n.s.). There was also no significant main effect of restraint (n.s.). To test the effect of restraint and stress on bias for unhealthy and healthy food words, MANCOVA was conducted, with the dependent variables of healthy and unhealthy food word biases, the independent variables of stress and restraint, and with hunger as a covariate. This showed that there was no significant interaction between restraint group and stress, nor was there a significant main effect of restraint for either healthy or unhealthy food word biases (all n.s.).

### **3.2.2.3 Correlations between Stroop and dot probe bias scores**

The relationships between the bias scores from each of the two tasks were tested using Pearson's Product Moment Correlation Coefficients. For the overall sample, there were no significant correlations between the two tasks for any of the different food bias scores. Correlation coefficients were also calculated for the stress and



control conditions separately, though no significant relationships were revealed in either the stress or control groups.

#### **3.2.2.4 Summary of findings**

The analysis of food bias scores for the Stroop task revealed the stress and control groups did not differ in bias for ego threat words. Bias scores for overall food words were greater for participants in the control group. There were no significant interactions between stress and external eating for any of the food words except for snacks, which was due to high external eaters demonstrating a greater bias for snack words when stressed, and low external eaters having a greater bias for snack words in the control condition. There were no significant interactions between external eating and stress for any of the food bias measures in the dot probe task. Restraint and stress condition did not interact to affect bias score for food words in either the Stroop or dot probe task, but those low in restraint had a significantly greater bias for unhealthy and snack food words in the Stroop task. The bias scores from the Stroop and dot probe tasks were uncorrelated.

#### **3.2.3 Discussion**

Study Three aimed to investigate whether high external eaters would attend towards food-related stimuli when stressed. It was hypothesised that external eating style and stress would interact, so that high external eaters would show a greater bias towards food words under stress, compared with high external eaters in a control condition, and low external eaters in either condition. It was further predicted that food biases would be greatest for unhealthy and snack food words within high external eaters. It was also predicted that dietary restraint would interact with stress, so that highly restrained individuals would show an attentional bias for food words when stressed. The final prediction was that participants in the stress condition would show an attentional avoidance of ego-threatening words.

#### ***Biases for ego threat words under stress***

The results from the modified Stroop task indicated that all participants showed an avoidance of ego threat words, except for low external eaters in the control condition, who had a slight mean positive bias. Previous reports have indicated that individuals avoid negative stimuli when stressed (Ellenbogen et al., 2002). An

avoidance of threatening stimuli is also implicit in Heatherton and Baumeister's (1991) explanation of stress-induced eating, which argues that individuals will reduce awareness of a stressor during stress. The results here did not tend to support this theory, as there was no greater avoidance of threatening words in the stress condition, and all bias indices were close to zero, showing that there was very little difference in response times for threat and neutral words. The general slight avoidance may reflect a low trait anxiety within the sample, and low severity of the threat (Mogg et al., 2000).

### ***Biases for food words in external eaters***

There was little evidence that external eaters in the stress condition showed greater attentional biases for the overall food words. In fact, all groups showed increased vigilance towards the food words, with the greatest mean bias score found among the low external eaters in the control condition. Therefore the first prediction was not supported. It is also difficult to explain why the low external eaters had such a large bias for these food words in the control condition. However, this finding is not incongruent with the prediction that high external eaters would shift their attention during stress. It could be speculated that the low external group have no reason to avoid food words under normal conditions, since they are less susceptible to disinhibition, but that they avoid food stimuli when stressed. In contrast, the high external eaters may try to avoid food stimuli under normal conditions, because they have a tendency to overeat in response to these food cues.

It was also predicted that high external eaters would particularly attend towards unhealthy and snack food words. This received partial support. The modified Stroop task showed an interaction between external eating and stress for snack word biases. The high external eaters increased their bias for snack words in the stress condition, while low external eaters had a greater attentional bias for snack words in the control condition. This indicates that high external eaters may shift their attention towards snack food stimuli when stressed, rather than food stimuli per se. While external eaters may avoid food stimuli under non-stressful conditions, this avoidance is not maintained during stress. Previous research has found that high external eaters increased their consumption of snacks with daily hassles (Conner et al., 1999). It could be speculated that snack intake is more susceptible to change than meal intake,



since snack foods are more accessible than meal foods but still tend to be energy-dense. Furthermore, a shift in attention towards snack stimuli during stress could contribute to the stress-related change in intake in high external eaters.

The dot probe task did not yield any evidence of bias towards food words in high external eaters or in the stress condition. Instead, bias scores were generally negative for food words presented in the dot probe across all conditions. There was also no evidence of a greater vigilance for unhealthy food words in external eaters in the dot probe task. This effect cannot be attributed to similar state anxiety levels in the stress and control groups, since the stress group showed a significantly greater state anxiety level than the control group.

These findings are consistent with Johansson et al. (2004), who also reported negative bias scores for food words in high external eaters using the dot probe paradigm, without the stress manipulation. It may be that the design of the dot probe was not sensitive to attentional biases for food words. It has been suggested that the dot probe task is susceptible to strategic processing, where an individual is able to shift his or her attention away from the salient stimuli before the dot appears (Broschott et al., 1999). Therefore any attentional shift towards certain stimuli can be counteracted by an avoidance of the same stimuli, and no differences are recorded. This is less of a problem for the Stroop task, as only one word is presented at a time and the individual cannot shift his or her attention between two words. The possibility of strategic processing on the dot probe task could be tested by presenting the food stimuli at different time intervals, especially at subliminal levels, where the presentation is too fast for the participant to keep shifting attention between the two stimulus types. Subliminal attentional biases have previously been found in anxiety patients, though not in patients with depression (Bradley et al., 1997; Mogg et al., 1995). Therefore, it would be interesting to replicate the dot probe task with varied stimulus exposure times, although biases for food have previously only been shown at a supraliminal level (Mogg et al., 1998).

### ***Biases for food words in restrained eaters***

Study Three also aimed to test whether restrained eaters would shift their attention towards food stimuli when stressed, therefore predicting an interaction between

restraint and stress for food bias scores. Previous studies have found mixed support for attentional biases for food in restrained eaters (e.g. Francis et al., 1997; Sackville et al., 1998), but they have not tested the role of stress, despite evidence of increased food intake in restrained eaters under stress (e.g. Schotte et al., 1990). The current study found no evidence of an interaction between restraint and stress condition in either the Stroop or dot probe task; therefore this prediction was not supported. Contrary to predictions, the highly restrained individuals had smaller biases for unhealthy and snack food words in the Stroop task than low restraint individuals, regardless of stress levels. Furthermore, the mean bias for snack food words was negative for highly restrained individuals, indicating an attentional avoidance of food words. This conflicts with previous reports of increased vigilance for food words in restrained eaters. One explanation for this finding is that the DEBQ was used to measure restraint in this study, a scale that arguably identifies individuals who are successful, rather than unsuccessful dieters (Ruderman, 1983). In this case, highly restrained individuals may be expected not to show a large bias for snack food words as they have a low tendency to disinhibit food intake.

### ***Strengths and limitations***

One strength of this particular study was that the high and low external eaters were classified according to the top and bottom twenty per cent of scores on the external eating scale of the DEBQ from a larger overall sample. This meant that high and low external eating groups were represented by individuals with scores at the extreme ends of the scale, which is likely to improve upon the median split technique that is often used to identify groups. However, the power of the study may have benefited from a larger overall sample, especially since several cases and response times were removed as outliers. A further limitation was that it was not possible to test attentional biases for snack words in the dot probe task, because there were not enough presentation trials for so few snack words.

### ***Conclusions***

The evidence for an attentional bias with stress in external eaters was mixed. There was little evidence to suggest a general bias towards food words in high external eaters during stress. However, the Stroop results did indicate a shift in attention towards snack food words in high external eaters in the stress condition. There was



no evidence of an interaction between dietary restraint and stress for food bias scores in either task, but the Stroop indicated that low restraint individuals attended towards unhealthy and snack foods more than highly restrained individuals, in contrast with previous findings. The lack of findings with the dot probe task could be attributable to strategic processing of stimuli. It was also not possible to test attentional biases for snack food words in the dot probe task in the current study. Therefore, it would be useful for a further study to test attentional biases for snack food words using a dot probe paradigm with different trial exposure times, to investigate a specific bias for snacks and to minimise the issue of strategic processing.

### **3.3 Study Four: Effect of exposure time on attention towards food words**

As an extension of Study Three, Study Four investigated the effect of exposure time on bias for food words, in addition to external eating style and stress, using a computerised dot probe. As before, the importance of food type was also investigated by testing bias scores for healthy, unhealthy, meal and snack words. An interaction between external eating and stress was predicted, so that external eaters would show heightened vigilance for food-related stimuli under stress. It was further predicted that external eaters would show attentional biases for snacks and unhealthy food words in particular. It was predicted that exposure time would affect biases towards food words in external eaters, so that a three-way interaction could be found between external eating group, stress and exposure time. However, the direction of the effect of exposure time was not predicted. As in Study Three a between groups design was used to test the effect of external eating to avoid practice and order effects with the dot probe task. However, to calculate bias scores, each participant completed all trials of the dot probe and therefore there was a within groups element to the design.

#### **3.3.1 Method**

##### ***Participants***

There were 52 participants in the sample, who were undergraduate and postgraduate students at the University of Leeds. There were 12 males in the sample, and 40 females, with the larger number of females reflecting the ratio of males to females

on Psychology courses. There were, however, similar ratios of males and females within the stress and control groups. The age of participants ranged from 18 to 58, with a mean of 23.87 years ( $SD=6.80$ ). There was a mean BMI of 22.58 ( $SD=3.16$ ). The sample was divided into high and low external eaters according to median score on the external eating scale of the DEBQ. Those with scores of 32 and under were categorised as low external eaters, and those with scores of 33 and above were categorised as high external eaters, which gave 24 low external eaters and 27 high external eaters. The low external eaters had a mean external eating score of 29.48, and the high external eaters had a mean score of 38.74. The mean for the high external eaters was similar to the group in study Three (mean external eating score of 39.83), but the low external eating group had a greater mean than the low external eating group in Study Three (mean of 24.03). One person in the control group did not complete the external eating scale, and so was not included in all analyses.

### ***Measures***

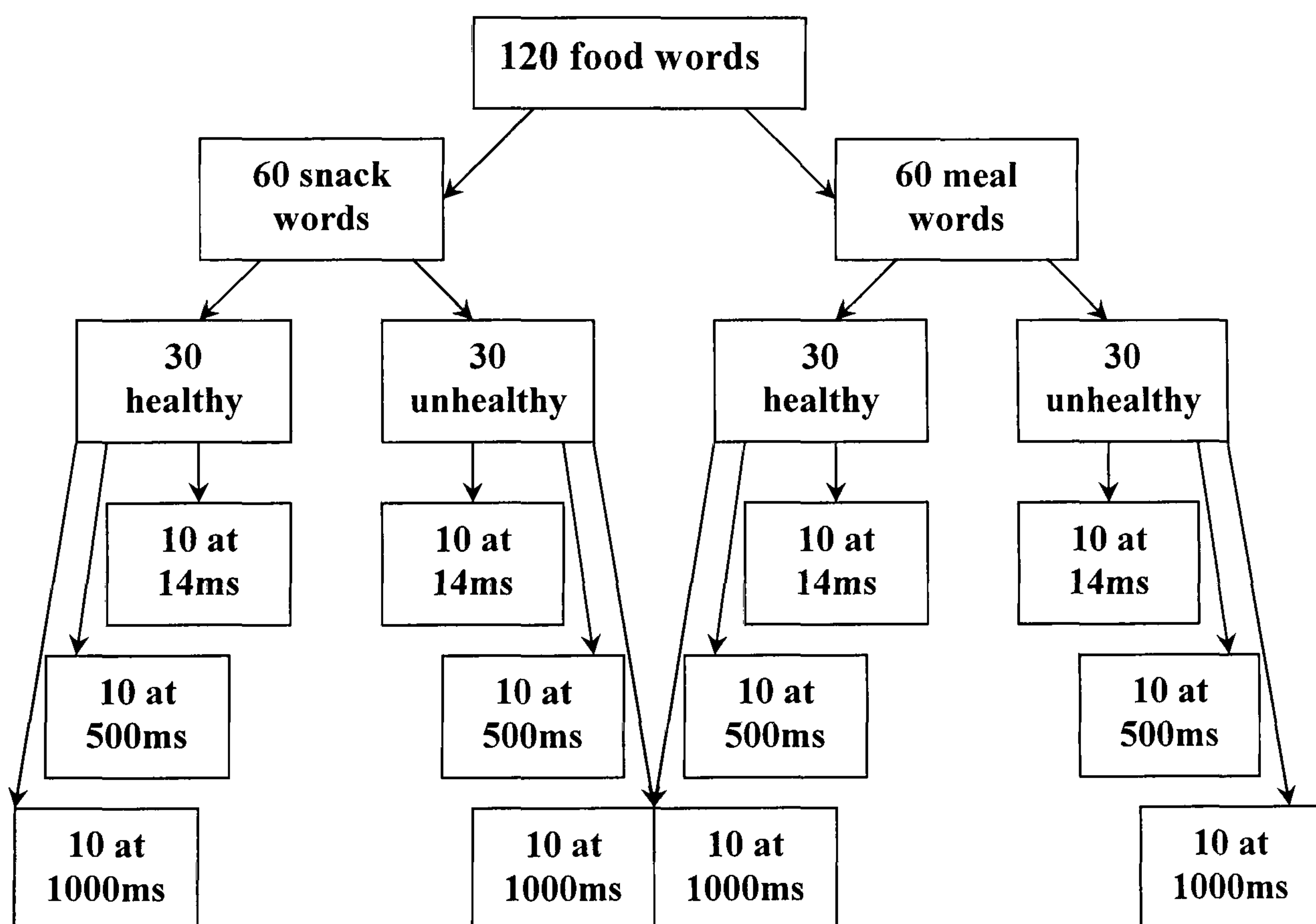
The participants recorded their gender and age on the study consent form. Hunger at the start of the experiment was recorded on a seven point anchored scale from ‘not at all’ to ‘extremely’, as in Study Three. An anchored scale was employed to measure hunger for ease of completion by participants. External eating style was measured using the DEBQ (Van Strien et al., 1986a), which showed high internal reliability in the current sample (Cronbach’s  $\alpha=0.84$ ). Anxiety before and after the stress manipulation was assessed using the shortened Spielberger State-Trait Anxiety Inventory (Marteau & Bekker, 1992).

### ***Materials***

The participants were presented with 120 word pairs in the dot probe task (see Appendix 3.5 for word pairs). Each word pair contained one food word, and one neutral word. The food words were divided into 60 snack and 60 meal foods, with their category status validated by ten independent raters. The words were also subdivided into healthy and unhealthy foods. Foods high in fat or sugar were categorised as unhealthy and foods low in fat or sugar categorised as healthy, using the values from McCance and Widdowson’s (1976) *Composition of Foods*, and divided according to the median value. Food words were also subdivided into different exposure times. Forty word pairs were presented for 14ms then replaced



by a mask for 186ms (total=200ms). This meant that participants were aware that a word pair had been presented before the onset of the probe, but the actual target words were below the awareness threshold. Forty word pairs were presented at 500ms, and a further forty pairs at 1000ms. The 500ms and 1000ms word pairs were not masked, as these exposure times were above the conscious level. The food and neutral word in each pair were matched for length and written frequency using Leech et al. (2001) and an online word frequency system (Wordcount; Harris, 2003). The words were further matched along these criteria between the three exposure time categories. Words in the 14ms condition were masked by replacing the target and neutral word pairs with a sequence of non-letter characters from a standard computer keyboard to the same length as the words. Figure 3.3 shows the different categories of food words.

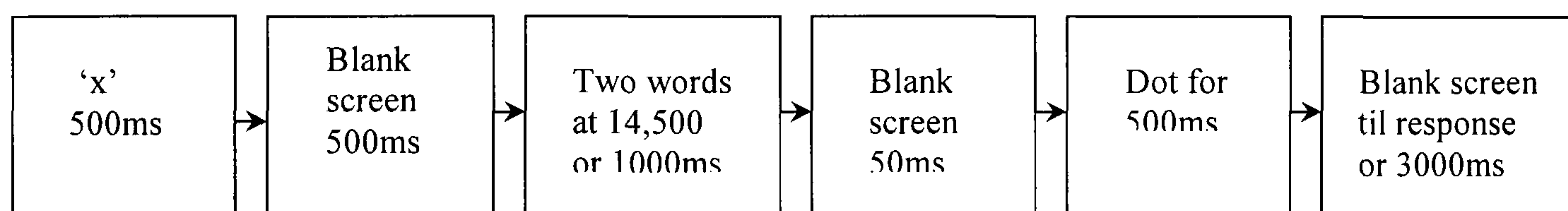


**Figure 3.3 Dot probe word categories in Study Four**

#### *Dot probe program*

The participants completed a computerised dot probe task, with a screen size of 9 inches by 13 inches. The program presented written instructions for the task, asking participants to respond as quickly and as accurately as possible. The word pairs were presented to the left and the right of the screen, before a dot appeared either on

the left or right, and the participant responded to the dot's location by pressing the corresponding left and right buttons on a handheld button box. In each trial, a fixation cross ('x') was presented in the middle of the screen for 500ms. After a 500ms pause, the two words were presented on the left and right of the screen for 14, 500 or 1000ms. A blank screen was shown for 50ms, before a 6mm diameter dot appeared on either the left or the right of the screen for 500ms. The participant was required to respond to the dot's location before the maximum 3000ms. Figure 3.4 shows the procedure for each dot probe trial.



**Figure 3.4 Study Four Dot probe trial protocol**

The 120 word pairs were presented to each participant in a random order to reduce order effects. In half the word pairs, the target word appeared on the left of the screen, and in the other half the target word appeared on the right hand side. The orientation of the dot was randomised between trials, but in half the trials it appeared on the right, and in half it appeared on the left. The participant was given four practice trials at the beginning.

#### ***Awareness check program***

A computerised awareness check program was devised, consisting of two tasks, based on the procedure of Bradley et al. (1997). This was to determine how aware of the subliminally presented words the participants were. In a 'lexical decision' task, the participants were shown the fixation cross for 500ms, followed by a word pair or nonsense word pair (made from normal letters) in the middle of the screen for 14ms, then a 186ms mask over both words using the non-letter keyboard characters, as in the dot probe (see Appendix 3.6 for list of stimulus pairs). The participant was required to respond by pressing the letter 'm' if he or she thought that there were real words presented before the mask, and the letter 'x' if he or she thought that there were nonsense words presented before the mask. Therefore, the lexical decision task required the participant to discriminate between two types of stimuli before the mask. In a 'presence/absence' task, either a word pair or a blank screen



was shown for 14ms then replaced by a mask of random non-letter characters for 186ms. The participant was required to press the letter 'x' on the keyboard if he/she thought that there had been a blank screen before the mask, and to press the letter 'm' to report a word pair before the mask. Therefore the purpose of the presence/absence task was to determine whether the participant was able to detect the presence of any stimuli before the mask. The order of the two tasks was counterbalanced across the participants to reduce order effects. Both tasks included 24 trials, with four practice trials at the start.

### ***Stress-induction protocol***

The stress procedure in Study Three was successful in increasing self-reported anxiety levels; therefore the same procedure was used in Study Four. In the stress condition, participants were asked to prepare a speech about their opinion on a controversial topic for assessment by a group of psychologists, and in the control condition the participants circled the letter 't' in an extract from Dr. Seuss's 'The Cat in the Hat'.

### ***Procedure***

Study Four followed the same procedure as Study Three. Participants were tested on an individual basis. They were provided with a study information sheet and consent form. Each participant completed the STAI state anxiety measure and a hunger rating before undergoing either the stress or control protocol for ten minutes. During this time, the participant was left alone in the laboratory room. After ten minutes, the experimenter re-entered the room and the participant was required to again complete the STAI measure. The participant completed the computerised dot probe task, followed by the awareness program. After completing the computer tasks, the participants in the stress condition were informed that they would not be asked to perform a presentation. The DEBQ external eating scale was completed after the computer tasks, and the participant was debriefed about the aims of the study.

### ***Statistical analysis***

Mixed ANCOVAs were used to test the interaction effects of external eating, stress condition and exposure time on biases for food words in external eaters. ANCOVA

was performed for food words overall, snack, meal, healthy and unhealthy food words, with hunger included as a covariate in all analyses.

### 3.3.2 Results

#### 3.3.2.1 Dot probe results

##### *Stress manipulation check*

Before the stress manipulation, the stress and control groups had very similar mean scores on the STAI, with a mean of 10.56 (3.06) for the stress group, and a mean of 10.26 (2.89) for the control group. An independent groups t-test revealed that there was no significant difference between the baseline anxiety scores for the stress and control groups ( $t(50)=0.37$ , n.s.). After the manipulation, the stress group had an increased mean anxiety score of 13.12 (SD=2.60), while the control group showed little change, with a mean of 10.52 (SD=3.03). An independent t-test revealed a significant difference in anxiety scores between the stress and control groups following the manipulation ( $t(50)=3.31$ ,  $p<0.01$ ). A paired t-test with a dependent variable of anxiety score and the independent variable of measurement point showed that there was a significant increase in anxiety rating post manipulation in the stress group ( $t(24)=-6.33$ ,  $p<0.01$ ), but not in the control group ( $t(26)=-0.65$ , n.s.). Therefore the manipulation appeared successful in increasing state anxiety levels. To check that both high and low external eaters responded in the same way to the stress manipulation, an independent t-test was conducted with a dependent variable of post manipulation anxiety score and independent variable of external eating group. This was found to be non-significant ( $t(49)=0.20$ , n.s.). Therefore there was no significant difference in response between the two groups.

##### *Treatment of response data*

All errorful trials were removed from the data, which led to the removal of 1.17% of response times. Outlying scores were determined using box and whisker plots, and times that were not in the range of 130ms to 540ms were excluded. This led to the removal of a further 2% of response times. Bias scores were calculated by subtracting the mean response time for trials where the dot replaced a food word from the mean response time for trials where the dot replaced a neutral word, so that



a positive score indicated a bias towards the food word. Scores were calculated for meal, snack, healthy and unhealthy food words at each presentation time and across times.

### ***Awareness checks***

The awareness checks for the lexical decision and presence/absence tasks were based on the procedure of Bradley et al. (1997). For the lexical decision task, the whole sample responded correctly on 629 out of 1248 trials, providing a correct response rate of 50.40%. Binomial tests were performed with the percentage correct scores for individual participants, using a chance level of 50%. These showed that no respondents scored significantly above this level, suggesting that they were unable to discriminate between real and nonsense words. In the presence/absence task, the whole sample responded correctly to 897 trials out of the total 1248, giving a 72% rate of correct responses. Binomial tests were performed for individual percentage correct scores, using a chance level of 50%. This was significant, indicating that many of the participants were able to discriminate between the presence of the stimulus and a blank screen at 14ms. However, the results of the lexical decision task showed that they were unable to detect the stimulus content.

### ***Bias scores***

Table 3.4 shows the bias scores for overall food, snack, meal, healthy and unhealthy food words, calculated for the high and low external eaters in the stress and control conditions at 14ms, 500ms and 1000ms exposure times.

### ***Overall food bias***

Table 3.4 shows that all four groups had positive bias scores for the food words overall, although high external eaters had more positive bias scores than did low external eaters. Both high and low external eaters had slightly more positive biases for food in the control condition compared with the stress condition. Low external eaters had the greatest bias scores for food words presented at 500ms in either condition; however, high external eaters showed different patterns between stress conditions, so that the greatest positive bias was at 1000ms presentation times in the stress condition, and at 14ms in the control condition. To test the interactions between stress, external eating and exposure time, repeated measures ANCOVA was conducted with a dependent variable of food word bias and independent variables of

stress condition, external eating and exposure time, and hunger as covariate. This revealed no significant interaction between stress and external eating group ( $F(1,46)=0.07$ , n.s.), and no significant three-way interaction between external eating, stress and exposure time ( $F(2,92)=1.05$ , n.s.). There were no significant main effects of stress, external eating and no two-way interactions between exposure time and stress, or exposure time and external eating (all n.s.).

**Table 3.4 Mean food bias scores (ms) for stress and control conditions, at 14ms, 500ms and 1000ms exposure times (N=51)**

| Word type by exposure condition | Mean bias (SD)             |                           |                             |                            |
|---------------------------------|----------------------------|---------------------------|-----------------------------|----------------------------|
|                                 | Low external control (N=5) | Low external stress (N=5) | High external control (N=5) | High external stress (N=5) |
| Food masked                     | 3.69 ( $\pm 20.39$ )       | -16.90 ( $\pm 16.12$ )    | 2.79 ( $\pm 12.68$ )        | 6.05 ( $\pm 12.79$ )       |
| Food 500ms                      | 3.68 ( $\pm 27.56$ )       | -0.88 ( $\pm 15.11$ )     | -1.74 ( $\pm 13.49$ )       | 2.54 ( $\pm 9.27$ )        |
| Food 1000ms                     | 16.63 ( $\pm 21.27$ )      | 10.23 ( $\pm 11.69$ )     | 5.04 ( $\pm 23.61$ )        | -14.05 ( $\pm 14.88$ )     |
| <b>Food overall</b>             | 7.03 ( $\pm 12.35$ )       | -3.12 ( $\pm 9.67$ )      | -0.11 ( $\pm 7.19$ )        | -3.81 ( $\pm 6.40$ )       |
| Snack masked                    | 0.42 ( $\pm 14.91$ )       | -19.71 ( $\pm 15.36$ )    | 13.11 ( $\pm 12.63$ )       | 18.07 ( $\pm 22.05$ )      |
| Snack 500ms                     | 12.24 ( $\pm 12.16$ )      | -5.22 ( $\pm 26.94$ )     | -10.86 ( $\pm 37.93$ )      | -5.92 ( $\pm 25.36$ )      |
| Snack 1000ms                    | 25.46 ( $\pm 27.10$ )      | 2.62 ( $\pm 17.86$ )      | 8.57 ( $\pm 31.59$ )        | -8.40 ( $\pm 15.64$ )      |
| <b>Snack overall</b>            | 12.39 ( $\pm 11.21$ )      | -8.27 ( $\pm 17.59$ )     | 0.31 ( $\pm 11.68$ )        | -0.62 ( $\pm 13.02$ )      |
| Meal masked                     | -2.35 ( $\pm 32.70$ )      | -17.50 ( $\pm 30.49$ )    | -11.53 ( $\pm 23.66$ )      | -6.97 ( $\pm 19.42$ )      |
| Meal 500ms                      | -2.34 ( $\pm 54.24$ )      | 1.48 ( $\pm 33.49$ )      | 7.00 ( $\pm 24.89$ )        | 10.59 ( $\pm 7.57$ )       |
| Meal 1000ms                     | 10.29 ( $\pm 26.22$ )      | 14.68 ( $\pm 14.81$ )     | 0.98 ( $\pm 31.56$ )        | -19.50 ( $\pm 16.56$ )     |
| <b>Meal overall</b>             | 0.87 ( $\pm 22.92$ )       | 2.58 ( $\pm 6.91$ )       | -0.76 ( $\pm 6.61$ )        | -8.52 ( $\pm 3.52$ )       |
| Healthy masked                  | 7.21 ( $\pm 16.03$ )       | -12.56 ( $\pm 22.01$ )    | -1.34 ( $\pm 4.38$ )        | 11.67 ( $\pm 27.96$ )      |
| Healthy 500ms                   | 11.96 ( $\pm 37.70$ )      | -1.30 ( $\pm 26.22$ )     | 3.04 ( $\pm 23.38$ )        | -2.85 ( $\pm 13.72$ )      |
| Healthy 1000ms                  | 13.47 ( $\pm 32.34$ )      | 10.18 ( $\pm 29.90$ )     | 3.00 ( $\pm 41.61$ )        | -18.64 ( $\pm 23.42$ )     |
| <b>Healthy overall</b>          | 11.21 ( $\pm 14.30$ )      | -0.51 ( $\pm 13.84$ )     | 0.78 ( $\pm 14.48$ )        | -4.77 ( $\pm 9.95$ )       |
| Unhealthy masked                | -3.51 ( $\pm 27.71$ )      | -22.05 ( $\pm 20.11$ )    | 6.41 ( $\pm 27.71$ )        | 0.61 ( $\pm 16.46$ )       |
| Unhealthy 500ms                 | -5.52 ( $\pm 19.80$ )      | -2.98 ( $\pm 14.30$ )     | -5.57 ( $\pm 35.67$ )       | 10.59 ( $\pm 10.96$ )      |
| Unhealthy 1000ms                | 20.98 ( $\pm 15.55$ )      | 9.55 ( $\pm 27.02$ )      | 7.51 ( $\pm 26.22$ )        | -7.98 ( $\pm 18.55$ )      |
| <b>Unhealthy overall</b>        | 3.18 ( $\pm 10.69$ )       | -4.81 ( $\pm 10.37$ )     | 1.15 ( $\pm 13.91$ )        | -3.73 ( $\pm 15.72$ )      |
| Hunger rating                   | 3.00 ( $\pm 1.87$ )        | 3.20 ( $\pm 2.28$ )       | 3.20 ( $\pm 1.30$ )         | 3.80 ( $\pm 2.17$ )        |



### ***Overall food bias***

Table 3.4 shows that all four groups had positive bias scores for the food words overall, although the high external eaters had more positive bias scores than did low external eaters. Both high and low external eaters had slightly more positive biases for food in the control condition compared with the stress condition. Low external eaters had the greatest bias scores for food words presented at 500ms in either condition; however, high external eaters showed different patterns between the stress and control conditions, so that the greatest positive bias was at 1000ms presentation times in the stress condition, and at 14ms in the control condition. To test the interactions between stress, external eating and stimulus exposure time, repeated measures ANCOVA was conducted, with the dependent variable of food word bias and independent variables of stress condition, external eating and exposure time, with hunger as a covariate. This revealed no significant interaction between stress and external eating group ( $F(1,46)=0.07$ , n.s.), and no significant three-way interaction between external eating, stress and exposure time ( $F(2,92)=1.05$ , n.s.). There were no significant main effects of stress, external eating and no two-way interactions between exposure time and stress, or exposure time and external eating (all n.s.).

### ***Snack and meal word biases***

Table 3.4 shows that both high and low external eaters had greater biases for snack food words in the control than in the stress condition, with the greatest contrast at 500ms exposure times. Both high and low external eaters had negative bias scores for snack food words presented at 500ms, showing an avoidance of these words. ANCOVA was conducted with snack food bias as a dependent variable, stress, external eating and exposure time as independent variables and hunger as covariate. This revealed that there was no significant interaction between stress condition and external eating group for snack word bias ( $F(1,46)=1.12$ , n.s.), and no three-way interaction between external eating, stress and exposure time ( $F(2,92)=0.81$ , n.s.). There were no main effects of external eating or stress, and no interactions between exposure time and stress or exposure time and external eating (all n.s.).

The biases for meal words were greater in the stress condition, for high and low external eaters. The greatest difference in bias scores between stress and control

conditions was observed at 500ms for both high and low external eaters. High external eaters had more positive biases for meal words overall than low external eaters. ANCOVA was performed with the independent variables of exposure time, stress and external eating group, a covariate of hunger and bias for meal words as the dependent variable. No significant interaction between external eating and stress emerged ( $F(1,46)=0.05$ , n.s.), nor between external eating, stress and exposure time ( $F(2,92)=0.07$ , n.s.). There were no main effects of external eating or exposure time (both n.s.). However, there was a marginally significant main effect of stress condition ( $F(1,46)=4.05$ ,  $p=0.05$ ), which indicated that biases for meal words were greater in the stress condition. There were no two-way interactions between exposure time and stress or exposure time and external eating (both n.s.).

### ***Healthy and unhealthy food biases***

Table 3.4 shows that both high and low external eaters had greater bias scores for healthy food words in the stress condition, especially for words presented at 14ms. The low external eaters generally had more positive biases for healthy food words than high external eaters. ANCOVA was performed with bias scores for healthy food words as the dependent variable, stress, external eating and stimulus exposure time as independent variables, and hunger as covariate. There was no significant interaction between stress condition and external eating group in bias for healthy foods ( $F(1,46)=0.02$ , n.s.). There was also no significant interaction between stress, external eating and stimulus exposure time ( $F(1,92)=0.59$ , n.s.). No main effects of external eating, stress or exposure time emerged (all  $p>0.05$ ), nor were there any interactions between exposure time and stress or exposure time and external eating (both n.s.).

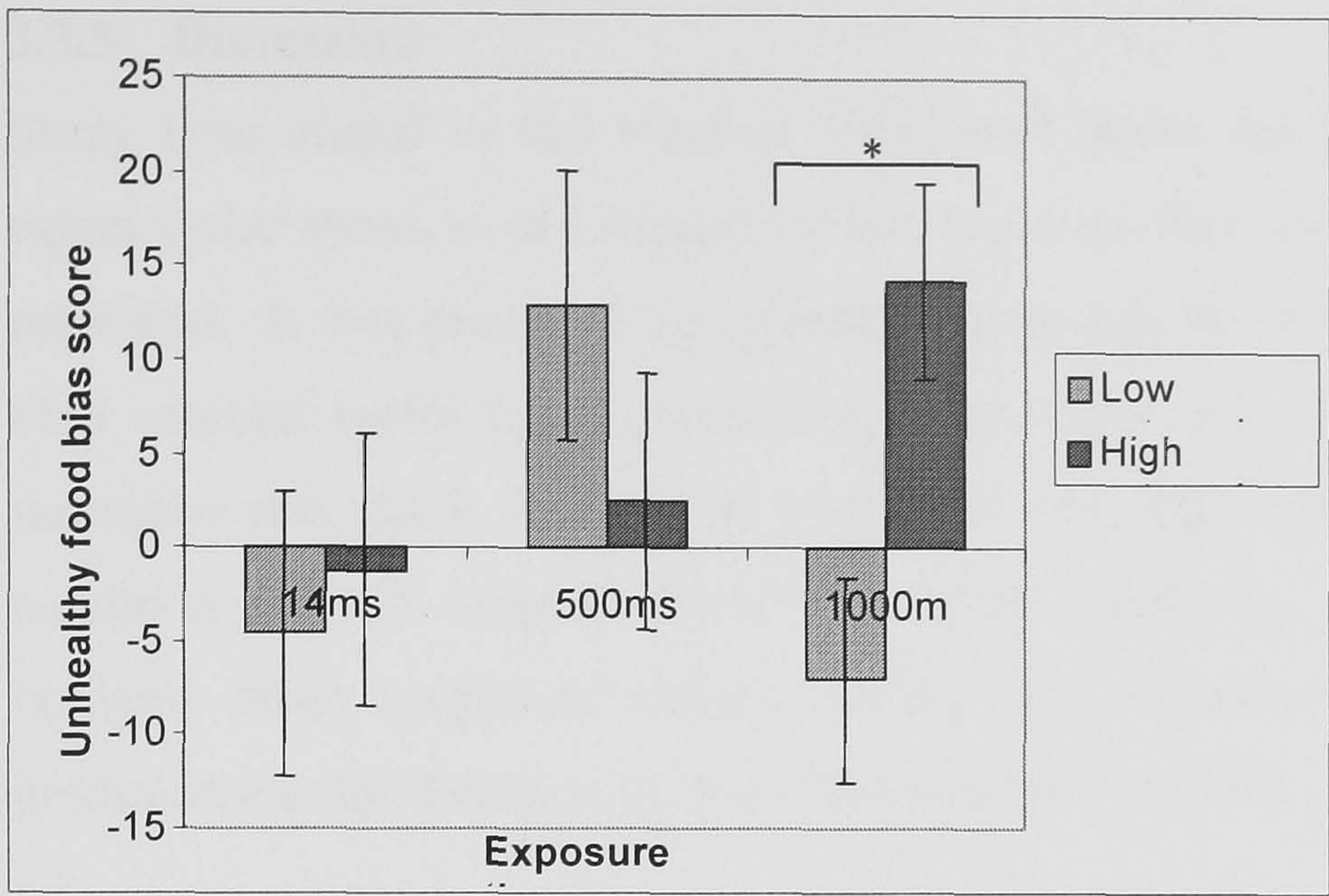
It can be seen from Table 3.4 that high external eaters had greater bias scores for unhealthy food words than did the low external eaters. However, both high and low external eaters had greater biases towards unhealthy food words in the control rather than the stress condition. Low external eaters in the stress condition showed a similar bias pattern across exposure times as the high external eaters in the control condition, so that the greatest positive bias for unhealthy words was at 500ms presentation times. The low external eaters in the control condition resembled the high external eaters in the stress condition, with the greatest bias scores at 1000ms



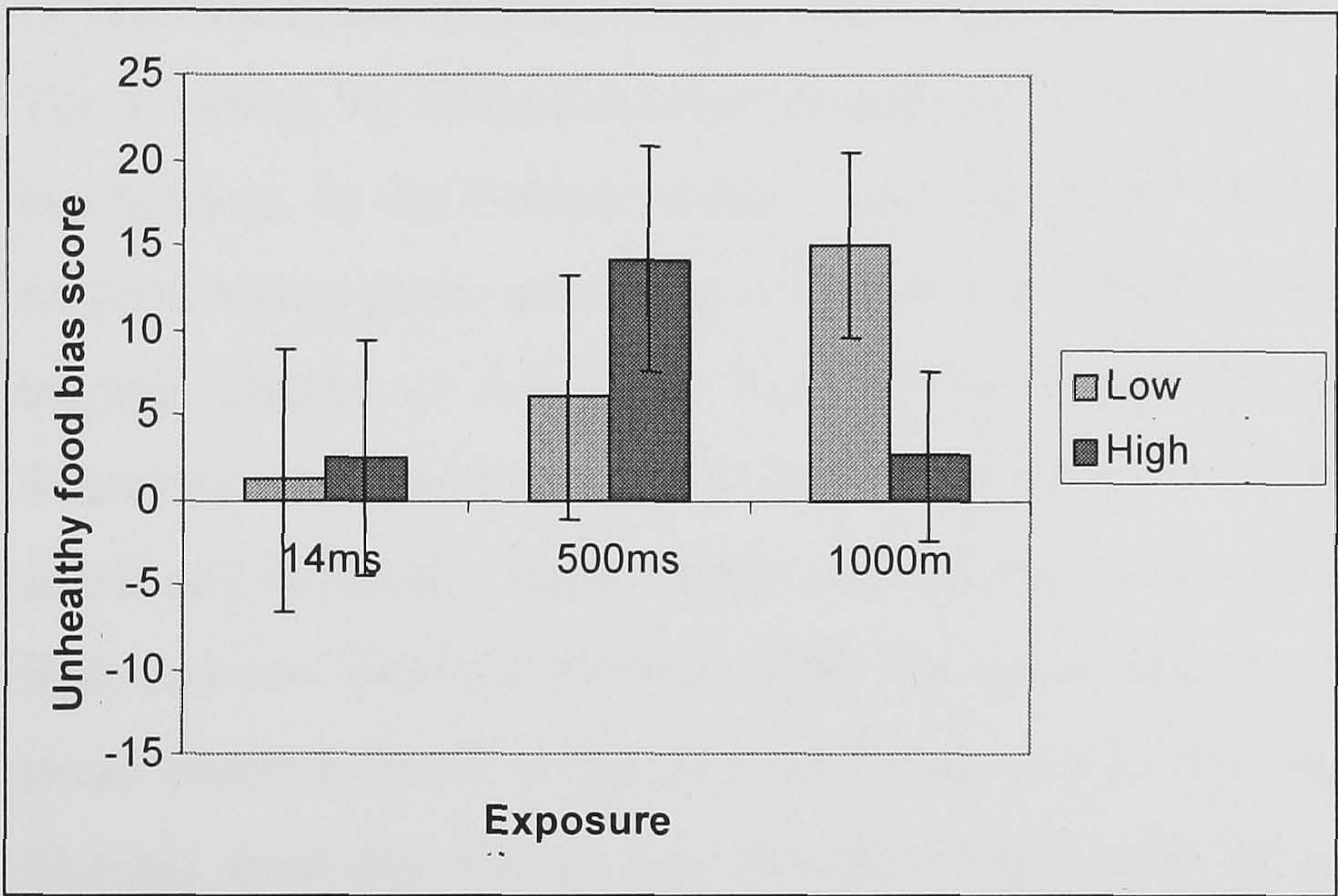
exposure times for both these groups. ANCOVA was conducted with stress, external eating and exposure time as independent variables, bias for unhealthy food words as the dependent variable and hunger as a covariate. This revealed no interaction between external eating and stress condition ( $F(1,46)=0.55$ , n.s.), no main effects of external eating, stress or exposure time (all n.s.), no interactions between exposure time and stress or exposure time and external eating. However, there was a significant three-way interaction between stress, external eating and stimulus exposure time ( $F(2,92)=3.90$ ,  $p<0.05$ ). The estimated marginal means indicated that in the stress condition, low external eaters had greater bias scores than high external eaters at 500ms, but that high external eaters had greater bias scores than low external eaters at 1000ms presentation times. In the control condition, this pattern was reversed. Figure 3.5 shows this interaction.

A series of follow-up independent samples t-tests were conducted to explore the interaction further. These highlighted a significant difference between the bias scores of low external eaters in the stress and control conditions for words presented at 1000ms ( $t(22)=-2.80$ ,  $p<0.05$ ). This indicated that low external eaters had a greater bias for unhealthy food words at this exposure time in the control condition than in the stress condition. There was also a significant difference between the bias scores of high and low external eaters in the stress condition for unhealthy words presented at 1000ms ( $t(23)=-2.79$ ,  $p<0.05$ ). In the stress condition alone, high external eaters had a significant greater bias score than low external eaters for words at this exposure time.





a.



b.

**Figure 3.5 Unhealthy food bias scores for high and low external eaters at 14ms, 500ms and 1000ms exposure times in a. stress condition and b. control condition**

**3.3.2.2 Summary of findings**

There were no significant interactions between stress and external eating for any of the food bias scores across exposure times. A three-way interaction between stress, external eating group and exposure time emerged for unhealthy food words. Within the stress condition, there was a significant difference in bias scores for unhealthy food words between high and low external eaters, but only for words presented at 1000ms. The high external eaters showed a mean positive bias score at this time in the stress condition, while the low external eaters had a mean negative bias at this exposure time.



### 3.3.3 Discussion

Study Four aimed to test whether attentional biases for food stimuli in external eaters under stress would depend on the exposure time and the type of food word presented. It was predicted that external eating and stress would interact, such that high external eaters in the stress condition would show heightened vigilance for unhealthy and snack food words compared with high external eaters in a control condition and low external eaters in the stress condition. A three-way interaction between stress condition, external eating and stimulus exposure time was also predicted, but the direction of this effect was not specified.

#### *Interaction between stress and external eating for food biases*

The evidence for attentional bias towards food stimuli in external eaters was rather inconsistent in the current study. No significant interactions emerged between external eating group and stress condition for overall food bias score, nor for biases towards snacks or unhealthy food words, across the stimulus exposure times. Therefore, the hypothesis that high external eaters would increase attention towards snack and unhealthy words when stressed was unsupported in this study. In fact, high and low external eaters in both the stress and control conditions all showed small positive biases towards food words across the exposure times. Since the findings from the Stroop task in Study Three showed an increased vigilance for snack food words in high external eaters during stress, it is particularly surprising that no interaction between stress and external eating was found here for snack food biases.

#### *Interaction between stress, external eating and exposure time for food biases*

The conjecture that attentional biases were dependent on exposure time was partially supported. For unhealthy food word biases, a three-way interaction between external eating, stress condition and exposure time was reported. This interaction was due to a number of effects with the longest exposure time, of 1000ms. Most notably, the high and low external eaters differed significantly in unhealthy food bias scores in the stress condition at the longest exposure time. The high external eaters had a positive bias for unhealthy food words in the stress condition, while the low external eaters had a mean negative bias. However, in the control condition, the low external eaters had a greater positive bias for unhealthy food words presented at

1000ms than did the high external eaters. This suggests that low external eaters avoid unhealthy food stimuli under stress, while high external eaters increase their vigilance for such stimuli when stressed, but that this difference is only apparent at greater exposure times. While a heightened vigilance was reported for unhealthy food words, this finding is broadly consistent with the increased bias in external eaters for snack food words under stress found in Study Three.

It is interesting to note that this interaction emerged for the unhealthy food stimuli, as the intake of unhealthy foods has been reported to increase in response to stress (e.g. Oliver & Wardle, 1999). It could be speculated that a change in attention towards unhealthy foods contributes to increased intake of unhealthy foods by external eaters when stressed. It remains unclear why the high external eaters would show an increased bias at the longest exposure time, though what does seem clear is that high external eaters do not have a preconscious bias towards food stimuli when stressed, as bias scores for unhealthy foods actually increased with exposure time in the stress condition. While preconscious biases have been found in anxiety patients (Mogg et al., 1995), they may not be prevalent within non-clinical subgroups, such as individuals high in external eating. Similarly, in hunger, biases towards food appear to emerge only at a supraliminal level, suggesting a conscious, not preconscious bias for food stimuli (Mogg et al., 1998).

### ***Strengths and limitations***

A strength of Study Four is that the stimulus exposure times were varied, which appeared to influence bias scores towards the food words. One limitation of this study was that the sample was divided into high and low external eaters using a median split, while Study Three took participants scoring in the top and bottom twenty per cent from a larger sample. This difference in group classification between Studies Three and Four may have contributed to a lesser consistency in the findings of Study Four. A second limitation of this study was the type of food stimuli presented to the participants. The use of food words meant that the stimuli were only semantically related to food. It is likely that food images, on the other hand, would be more salient cues for food intake than words, and so images would be more valid stimuli. It is also possible that the type of stimuli used was a factor in the lack of consistency within the findings in both Studies Three and Four.



Therefore, a useful extension to the previous two studies would be to test attentional biases towards pictorial stimuli.

### ***Conclusions***

The results from Study Four showed evidence of an attentional shift towards unhealthy food words in stressed, external eaters at the longest exposure time, while stressed, low external eaters showed an avoidance of unhealthy food words at this exposure time. Therefore, attentional biases towards food did appear to vary with exposure time, so that differences between high and low external eaters were more obvious at greater exposure times. The findings of the current study did not find evidence of attentional biases towards snack stimuli in high external eaters in the stress condition, in contrast to the findings reported in Study Three. However, inconsistencies between the findings of Studies Three and Four could be partly due to the use of word stimuli. The use of food images as stimuli could improve the salience of the stimuli, and consequently help to elucidate the differences in findings between the previous two studies.

### **3.4 Study Five: Effect of exposure time on attention towards food images**

Study Five was an exploratory study aimed to extend Studies Three and Four by using pictorial stimuli to test attentional biases for food in external eaters. It was predicted that external eating and stress would interact to affect food biases, so that high external eaters would show an increase in bias towards food images when stressed. In particular, biases towards unhealthy and snack foods were expected to increase in high external eaters. It was also predicted that bias for food stimuli in external eaters would depend on the exposure time of stimuli, therefore an interaction between stress, external eating and exposure time was predicted.

#### **3.4.1 Method**

##### ***Participants***

Twenty participants took part in Study Five. Of the twenty, 6 were males and 14 were female, with an equal number of males and females across the stress and control conditions. The sample was divided into high and low external eaters using the median value. Those with scores of 34 and below were categorised as low

external eaters, while those with scores of 35 and above were categorised as high external eaters. This meant that 10 participants were categorised as low external eaters and 10 as high external eaters. Due to the exploratory nature of the study, sample sizes were small. These cut off points differed slightly from those of Study Four, as external eating scores were slightly higher on average. The low external eaters had a mean external eating score of 28.80, while high external eaters had a mean score of 40.10. These mean values were similar to those in Study Four. The participants had an age range of 18 to 47, with a mean age of 25.40 years ( $SD=7.51$ ). The BMI of the participants ranged from 17.47 to 27.28, with a mean of 21.96 ( $SD=2.41$ ).

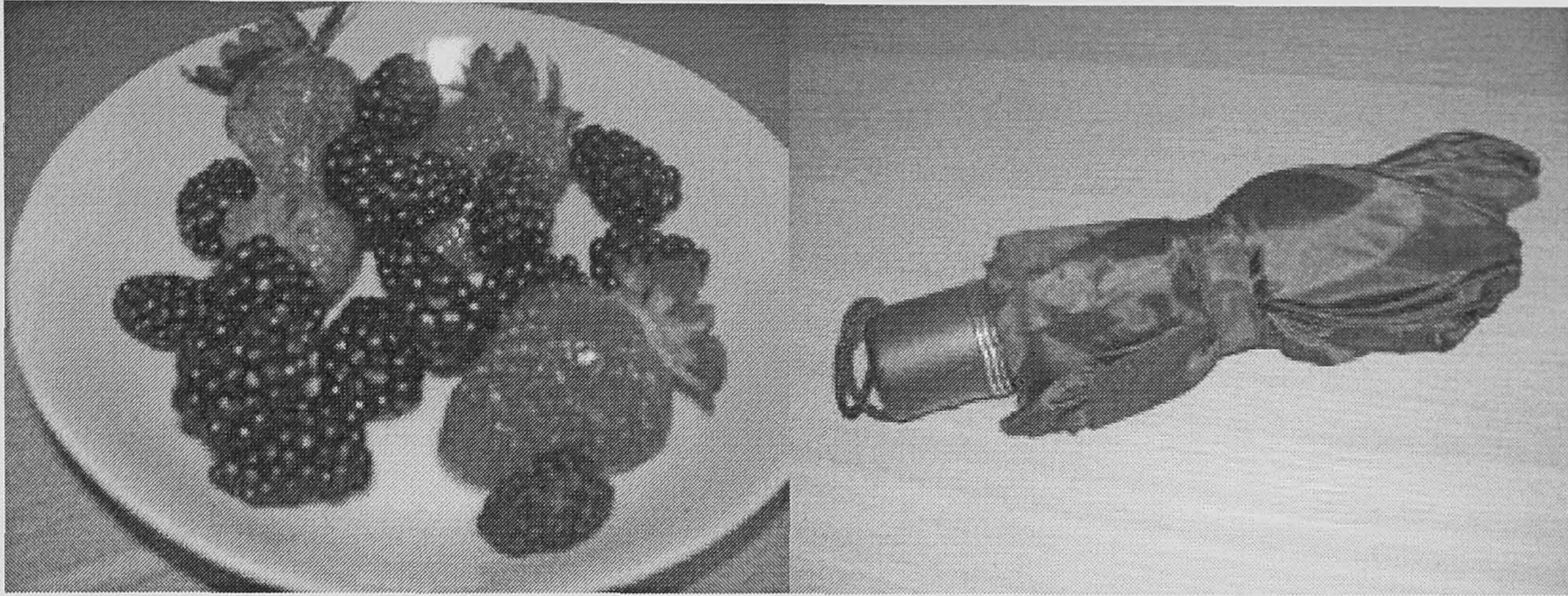
### *Measures*

Gender and age were recorded on the study consent form, and height and weight were recorded by questionnaire, to allow BMI to be calculated. Hunger was measured at the start of the study, using a seven-point anchored scale from 'not at all' to 'extremely hungry'. External eating was measured using the DEBQ (Van Strien et al., 1986a), and showed high internal reliability in the current sample (Cronbach's  $\alpha=0.89$ ). Anxiety before and after the stress manipulation was assessed using the shortened Spielberger State-Trait Anxiety Inventory (Marteau & Bekker, 1992).

### *Materials*

The dot probe task presented the participants with 120 pairs of pictures. All pictures were greyscale images, and resized to the dimensions of 6cm by 8cm (Lubman et al., 2000; Rohner, 2002). In addition, images in each pair were matched for contrast by eye, so that one image would not be more prominent than the other. However, pictures were not matched for visual complexity. Each image pair contained one food picture and one neutral picture. Independent judges checked that neutral images were not emotionally arousing, and any emotional arousing images were removed. The food, neutral and mask pictures were photographed using a Fuji Finepix S3000 3.2 megapixel digital camera, with images matched to the words in Study Four. The pictures were masked using a greyscale image of a brick wall. All the images were edited using Paint Shop Pro version 8 (Jasc Software, 2003). Figure 3.6 shows example images from the food and neutral categories.





**Figure 3.6 Example food and neutral images for dot probe**

The food images were subdivided into 60 snacks, 60 meals, 60 unhealthy and 60 healthy foods (see Figure 3.3), with 20 from each set presented at the three exposure times: 14ms (followed by 186ms mask), 500ms and 1000ms.

### ***Dot probe program***

The dot probe task was computerised and shown on a Toshiba laptop, with a screen size of 9 inches by 13 inches. The program instructions directed the participants to respond to the images as quickly and accurately as possible. In each trial, a fixation cross appeared in the centre of the screen for 500ms, then the two images were presented simultaneously, with one picture on the left and one on the right for 14, 500 or 1000ms. After 50ms, the pictures were replaced by a 6mm diameter dot on either the left or right of the screen for 500ms. The participant was required to respond to the dot's location as quickly as possible, within the time limit of 3000ms. The participant was required to respond to the dot's location by pressing the letter 'm' on the keyboard if it was on the right of the screen, and by pressing the letter 'x' if it was on the left of the screen. The order of presentation was randomised for each participant to reduce order effects. In half the trials the food picture appeared on the left, and on half the trials it appeared on the right of the screen. Similarly, the dot appeared on the left of the screen in half the trials, and on the right in half the trials. There were four practice trials at the start of the task. See Appendix 3.5 for image pairs.



### ***Awareness check program***

An awareness program was devised, consisting of two tasks, based on the procedure by Bradley et al. (1997). In a ‘content discrimination’ task, the participant was presented with a pair of food pictures or a pair of neutral pictures for 14ms, followed by the mask picture of bricks for 14ms. The participant was instructed to press the letter ‘m’ on the keyboard for food pictures before the mask, or the letter ‘x’ for non-food words before the mask. Participants were asked to guess if unsure. Therefore, the task required the participant to discriminate between the contents of the images. There were 4 practice trials, followed by 24 experimental trials (see Appendix 3.6).

The participants also completed a ‘presence/absence’ task, where they were presented with either a blank screen or an image pair for 14ms followed by the mask picture for 186ms. The participant was required to respond by pressing the letter ‘m’ for food pictures before the mask, and by pressing the letter ‘x’ for a blank screen before the mask. As before, the participant was encouraged to guess if unsure. There were 4 practice trials, followed by 24 experimental trials. The order of the presence/absence and content discrimination tasks was counterbalanced across participants.

### ***Stress-induction protocol***

Study Five used the same stress protocol as Studies Three and Four, so that participants prepared a speech of their opinion on a controversial topic in the stress condition, and circled every letter ‘t’ in an extract of Dr. Seuss’s ‘The Cat in the Hat’. In both conditions, the participant was left to complete the task for ten minutes.

### ***Procedure***

The procedure to Study Five was identical to Study Four. After reading the information sheet and completing the consent form, hunger and state anxiety were measured. The stress induction or control protocol was completed for ten minutes, with the participant on his/her own in the laboratory. After this period, state anxiety was again measured. The dot probe was completed by the participant, followed by the awareness check program. At this point, participants in the stress condition were informed that they would not be asked to perform the speech. The participant



completed the DEBQ external eating scale in the laboratory, before being debriefed about the aims of the study.

### ***Statistical analysis***

Mixed ANCOVAs were conducted to test the interaction effects between external eating, stress and stimulus exposure time for food, snack, meal, healthy and unhealthy food bias scores. In all cases, hunger rating was included as a covariate.

## **3.4.2 Results**

### **3.4.2.1 Dot probe results**

#### ***Stress manipulation check***

The stress and control groups had similar state anxiety scores before the manipulation, with a mean score of 11.60 (3.47) for the stress group and mean score of 10.30 (2.16) for the control group. An independent samples t-test showed no significant difference in state anxiety between the stress and control groups before the manipulation ( $t(18)=1.01$ , n.s.). The stress group had an increased anxiety score of 15.50 (2.72) following the stress manipulation, while the control group showed little change from before the manipulation, with a mean anxiety score of 10.10 (3.18). An independent groups t-test showed that the stress group score significantly high on state anxiety after the manipulation ( $t(18)=4.08$ ,  $p<0.01$ ). A paired samples t-test also showed that there was a significant increase in anxiety after the stress manipulation in the stress group ( $t(9)=-3.03$ ,  $p<0.05$ ). However, there was no significant change in anxiety before and after the manipulation in the control group ( $t(9)=0.35$ , n.s.). Therefore the stress manipulation was successful in increasing state anxiety. To test whether high and low external eaters responded similarly to the stress manipulation, an independent t-test was conducted with a dependent variable of post-manipulation anxiety score and independent variable of external eating group. This was found to be non-significant ( $t(17)=-0.65$ , n.s.), indicating no differences in response between the two groups.

### ***Treatment of dot probe data***

All trials with incorrect responses were removed from the response time data. This led to a removal of 0.75% of the response times. A box and whisker plot of all response times was used to determine outliers in the times, and all times above 630ms and below 180ms were excluded. This led to the removal of a further 4.63% of the response times.

Bias scores for food images were calculated by subtracting the mean response time for each type of food image from mean time for neutral images. Therefore, a positive bias score indicated a bias towards the food stimuli, and a negative bias score indicated avoidance of the stimuli.

### ***Awareness checks***

For the content discrimination task, the whole sample gave the correct response on 379 trials out of 480, meaning that 78.96% trials were correct. This appeared considerably greater than the 50% chance rate. A binomial test was conducted with the percentage of correct responses for each participant in the content discrimination task, using a chance level of 50%. This was significant, indicating that a greater number of scores were above 50% than would be expected by chance.

In the presence/ absence task, the overall sample gave correct responses on 419 out of 480 trials, giving an 87.29% correct response rate. The binomial test indicated that this was significantly above chance levels. The awareness checks showed that most of the participants were able to detect the presence or absence of stimuli before the mask, and that many were able to discriminate between the food and non-food pictures. It was possible that the pictures were not presented as quickly as 14ms, despite the pre-set timings, due to the size of the pictures. The 14ms exposure times are referred to as masked exposure times in the subsequent analysis.

### ***Bias scores***

Bias scores were created for overall food pictures, snacks, meals, unhealthy foods and healthy foods for high and low external eaters in the stress and control conditions, in the masked, 500ms and 1000ms exposure conditions. These bias scores are shown in Table 3.5.



**Table 3.5 Mean bias scores (ms) for high and low external eaters in the stress and control conditions (N=20)**

| Word type by exposure condition | Mean bias (SD)            |                            |                            |                             |
|---------------------------------|---------------------------|----------------------------|----------------------------|-----------------------------|
|                                 | Low external stress (N=5) | Low external control (N=5) | High external stress (N=5) | High external control (N=5) |
| Food masked                     | -16.90 (16.12)            | 3.69 (20.39)               | 6.05 (12.79)               | 2.79 (12.68)                |
| Food 500ms                      | -0.88 (15.11)             | 3.68 (27.56)               | 2.54 (9.27)                | -1.74 (13.49)               |
| Food1000ms                      | 10.23 (11.69)             | 16.63 (21.27)              | -14.05 (14.88)             | 5.04 (23.61)                |
| <b>Food overall</b>             | -3.12 (9.67)              | 7.03 (12.35)               | -3.81 (6.40)               | -0.11 (7.19)                |
| Snack masked                    | -19.71 (15.36)            | 0.42 (14.91)               | 18.07 (22.05)              | 13.11 (12.63)               |
| Snack 500ms                     | -5.22 (26.94)             | 12.24 (12.16)              | -5.92 (25.36)              | -10.86 (37.93)              |
| Snack 1000ms                    | 2.62 (17.86)              | 25.46 (27.10)              | -8.40 (15.64)              | 8.57 (31.59)                |
| <b>Snack overall</b>            | -8.27 (17.59)             | 12.39 (11.21)              | -0.62 (13.02)              | 0.31 (11.68)                |
| Meal masked                     | -17.50 (30.49)            | -2.35 (32.70)              | -6.97 (19.42)              | -11.53 (23.66)              |
| Meal 500ms                      | 1.48 (33.49)              | -2.34 (54.24)              | 10.59 (7.57)               | 7.00 (24.89)                |
| Meal 1000ms                     | 14.68 (14.81)             | 10.29 (26.22)              | -19.50 (16.56)             | 0.98 (31.56)                |
| <b>Meal overall</b>             | 2.58 (6.91)               | 0.87 (22.92)               | -8.52 (3.52)               | -0.76 (6.61)                |
| Healthy masked                  | -12.56 (22.01)            | 7.21 (16.03)               | 11.67 (27.96)              | -1.34 (4.38)                |
| Healthy 500ms                   | -1.30 (26.22)             | 11.96 (37.70)              | -2.85 (13.72)              | 3.04 (23.38)                |
| Healthy 1000ms                  | 10.18 (29.90)             | 13.47 (32.34)              | -18.64 (23.42)             | 3.00 (41.61)                |
| <b>Healthy overall</b>          | -0.51 (13.84)             | 11.21 (14.30)              | -4.77 (9.95)               | 0.78 (14.48)                |
| Unhealthy masked                | -22.05 (20.11)            | -3.51 (27.71)              | 0.61 (16.46)               | 6.41 (27.71)                |
| Unhealthy 500ms                 | -2.98 (14.30)             | -5.52 (19.80)              | 10.59 (10.96)              | -5.57 (35.67)               |
| Unhealthy 1000ms                | 9.55 (27.02)              | 20.98 (15.55)              | -7.98 (18.55)              | 7.51 (26.22)                |
| <b>Unhealthy overall</b>        | -4.81 (10.37)             | 3.18 (10.69)               | -3.73 (15.72)              | 1.15 (13.91)                |
| Hunger rating                   | 3.20 (2.28)               | 3.00(1.87)                 | 3.80 (2.17)                | 3.20 (1.30)                 |

### ***Overall food image bias***

High external eaters had negative bias scores for food images overall in both the stress and control conditions, showing an avoidance of these stimuli. The low external eaters had a more positive food bias overall than high external eaters, although low external eaters in the stress condition had a negative bias score for food images, while low external eaters in the control condition had a positive mean

bias score. The high external eaters in the stress condition showed less positive bias scores as the exposure time of the food stimuli increased. To test the effects of external eating, stress condition and exposure time, a mixed design ANCOVA was conducted, with the dependent variable of food bias score, independent variables of stress condition, external eating and stimulus exposure time, and hunger as a covariate. This revealed no significant interaction between stress condition and external eating group ( $F(1,15)=1.12$ , n.s.), and no significant interaction between stress, external eating and image exposure time ( $F(2,30)=1.13$ , n.s.). There were no main effects of external eating group or exposure time (both n.s.), but there was a main effect of stress ( $F(1,15)=4.90$ ,  $p<0.05$ ), indicating that those participants in the control condition had a significantly greater bias towards the food images. There were no significant two-way interactions between exposure time and stress, or exposure time and external eating group.

#### ***Bias for snack and meal food images***

Table 3.5 shows that both high and low external eaters had a mean positive bias for snack images in the control condition and a negative bias (avoidance) in the stress condition, with the greater difference between conditions in the low external eaters. Bias scores for snack images appeared to vary with exposure time in high external eaters in the stress condition, so that the bias shifted from positive to negative as the exposure time increased. To test the interactions between exposure time, stress and external eating, mixed design ANCOVA was performed, with the dependent variable of bias for snack images, independent variables of stress condition, external eating and exposure time, and hunger as a covariate. No significant interaction emerged between stress and external eating ( $F(1,15)=3.59$ , n.s.), or between stress, external eating and exposure time ( $F(2,30)=0.22$ , n.s.). There were no main effects of exposure time or external eating (both n.s.), but there was a main effect of stress ( $F(1,15)=5.55$ ,  $p<0.05$ ), where the control group had a significantly greater bias towards snack images than did the stress group. There were no significant two-way interactions between exposure time and stress, but there was a significant interaction between exposure time and external eating ( $F(2,30)=3.86$ ,  $p<0.05$ ). An examination of the estimated marginal means indicated that bias scores for snack images increased with exposure time in low external eaters, but decreased in high external eaters. ANCOVA was conducted with the bias for meal images as the dependent



variable. This revealed no significant main effects of exposure time, external eating and stress, and no interactions between the independent variables.

#### ***Bias for healthy and unhealthy food images***

Table 3.5 shows that the high and low external eaters in the stress condition had mean negative bias scores for unhealthy food images, while those in the control condition showed positive bias scores. Mixed ANCOVA was conducted with the independent variables of stimulus exposure time, external eating and stress, the dependent variable of bias for unhealthy food images and hunger as a covariate. This revealed no significant interaction between stress and external eating ( $F(1,15)=0.58$ , n.s.), and no significant three-way interaction between stress, external eating and image exposure time ( $F(2,30)=0.25$ , n.s.). There were no significant main effects of external eating, stress or exposure time, and no interactions between exposure time and stress or exposure time and external eating group.

The same ANCOVA was conducted with bias for healthy food images as the dependent variable. This revealed no significant main effects or interactions between stimulus exposure time, stress and external eating (all n.s.).

#### **3.4.2.2 Summary of findings**

There were no three-way interactions between external eating, stress condition and exposure time for any of the food bias measures. There were also no two-way interactions between stress and external eating group for any of the food bias scores. Main effects of stress emerged for food images overall and snack images, where the control group had greater positive bias scores. There was also a significant interaction between stimulus exposure time and external eating group for snack images. Bias scores for snack images increased with exposure time in low external eaters, but decreased with time in high external eaters.

#### **3.4.3 Discussion**

Study Five aimed to test whether external eaters attend towards food images when stressed, and whether this would depend on stimulus exposure time. It was predicted that stress and external eating would interact so that high external eaters

would show heightened vigilance for food images when stressed, especially for images of snacks and unhealthy foods. A three-way interaction between stress, external eating and stimulus exposure time was also predicted.

### *Food biases in stressed, external eaters*

The present study reported no interactions between stress and external eating style for bias towards overall food, snack and unhealthy food images. Therefore the first prediction was not supported. In fact, the greatest positive bias scores were found among the low external eaters in the control condition, for overall food, snacks and unhealthy foods. This is similar to the Stroop findings from Study Three, where low external eaters in the control condition had the greatest bias scores towards food words. As in Study Three, this finding seems counterintuitive. Again, one possible account for these findings is that low external eaters do not try to avoid food-related stimuli, since this subgroup are unlikely to increase consumption in response to such cues.

It was also reported that high external eaters in the stress condition had negative bias scores for food, snack and unhealthy food images. This suggests that the high external eaters avoided the food-related images when stressed, rather than attending towards them. Therefore the theory that attentional shifts towards food stimuli account for increased intake during stress was not supported by this study. However, this pattern of results is comparable to Johansson et al.'s (2004) findings, where high external eaters had negative bias scores for food words in a dot probe task. The Johansson et al. study did not include a stress manipulation; however, the results from the present study did not find any evidence that stress heightened vigilance for food stimuli in external eaters per se. Instead, a main effect of stress across high and low external eaters was reported, such that biases towards food and snack stimuli were greater in the control condition.

The lack of interaction between stress and external eating for snack food bias is incongruent with the Stroop findings from Study Three, where external eaters increased their attention towards snack words in the stress condition. One explanation for this discrepancy was the difference in classification of external eaters between the studies. While Studies Four and Five used a median split to



determine high and low external eating groups, only those with scores from the top and bottom twenty per cent from a much larger sample were selected for Study Three. However, it is interesting that the dot probe tasks in all three studies have failed to find an interaction between external eating and stress condition for bias scores. One explanation for this difference between the Stroop and dot probe findings is that the two tasks are not equivalent measures of attention. On the surface, the two tasks are different in that the dot probe task allows the participant to shift attention between two stimuli presented at the same time, whereas all the information is contained within one item in the Stroop trials.

It has also been suggested that the two tasks measure different stages of the attentional process, so that the Stroop interference measures a bias in the early stages of processing, while the time lag between the presence of stimuli and the probe in the dot probe task means that a later stage of attentional processing is gauged (Broschott et al., 1999). The use of varied exposure times in Studies Four and Five was aimed at counteracting this problem, since there was less time to process the relevance of information before responding to the probe's location. The results from the current study did show an interaction between exposure time and external eating for snack images, where biases were greater with shorter exposure times. However, Study Four reported that food biases in stressed external eaters were greater with increased exposure times, rather than the subliminal trials. Therefore the findings are inconclusive. It may be the case that shorter exposure times reduce continuous attentional shifts between the salient and neutral stimuli before the probe appears; but that the time-gap between the presence of the stimulus and the probe enables the participant to make a decision regarding the relevance of the stimulus, and consequently disengage before the onset of the probe.

### ***Strengths and limitations***

One strength of this study was that food images were used rather than food words. Images are likely to be much more salient cues to external eaters than food words, as the stimulus content does not require semantic processing, and further information can be obtained by maintaining attention towards pictorial stimuli (Bradley et al., 1998). However, olfactory cues would also not require semantic processing and would be expected to be salient eating cues for high external eaters. Therefore, if

possible, it would be interesting for future research to study attentional or awareness responses to food olfactory cues under stress. A further strength of the current study was that the pictorial stimuli were presented at different exposure times, to explore whether biases are subliminal or supraliminal, and whether processing strategies could be used at longer presentation times. However, the awareness tasks indicated that some of the participants were able to discriminate between the masked food and masked neutral pictures. It seems plausible that pictures could be recognised faster than words, which could have contributed to the ability of some participants to discriminate the image content. However, previous studies have not reported such a large awareness rate with stimuli presented at 14ms (e.g. Mogg & Bradley, 1999), which suggests that the images were not presented at as fast a rate as was programmed. Study Five was an exploratory study with a small sample size. This meant that there was little statistical power to determine any three-way interactions between eating style, stress and exposure time. Therefore, it would be interesting to conduct the study within a larger sample, with the masked images matched for visual complexity and shown at a shorter exposure time.

### ***Conclusions***

The results did not suggest evidence of an attentional shift towards food stimuli in external eaters when stressed. The greatest bias scores were found among the low external eaters in the control condition, and high external eaters appeared to avoid food stimuli when stressed. There was little evidence that stimulus exposure time affected biases in stressed, external eaters, although biases for snacks decreased with exposure time in this group. It is possible that differences between previous Stroop findings and the dot probe findings reported here are due to the two tasks measuring different stages of attentional processing. A replication of the study with a larger sample size and subliminal stimuli presented at a faster rate would help to address the issue further.

### **3.5 General discussion**

Studies Three, Four and Five tested the theory that attentional shifts towards food stimuli during stress could account for stress-induced eating, based on Heatherton and Baumeister's (1991) escape theory. Actual food intake was not measured within the three studies and only cognitive processes were focused on, as the studies



aimed to test an underlying mechanism for stress-induced eating. It was theorised that individuals susceptible to stress-induced eating shift their attention towards food stimuli when stressed, which would then promote food intake. In particular, it was theorised that attentional biases would be observed for snack and unhealthy food stimuli, since evidence has shown a preference for these foods during stress (e.g. Conner et al., 1999; Oliver & Wardle, 1999). Study Three tested attentional biases for food words in restrained and external eaters, using both a modified Stroop and dot probe design. Study Four also tested whether external eaters showed increased vigilance for food words when stressed using a dot probe task, but also varied the stimulus exposure times. Study Five replicated the procedure of Study Four, using pictorial food stimuli.

Taken together, the three studies provided mixed support for an attentional bias mechanism of stress-induced eating in external eaters. Study Three reported a significant interaction between stress condition and external eating group for snack food words in the modified Stroop task. While low external eaters showed a greater positive bias for snack food words in the control condition, the high external eaters showed a greater vigilance for snack words in the stress condition. Study Four did not replicate this interaction between stress and external eating in the dot probe task. However, Study Four did report a significant interaction between stress, external eating and exposure time. High external eaters showed an increased attentional bias for unhealthy food words presented at 1000ms, i.e. above conscious awareness, while low external eaters showed a negative bias for unhealthy food words at this exposure time. These two significant findings from Studies Three and Four are generally consistent in showing an attentional bias for food stimuli in external eaters during stress, although they reported increased awareness for different food types during stress. It is of particular interest that these biases were observed for unhealthy and snack food stimuli, since previous studies have highlighted that the intake of both snacks and unhealthy food is susceptible to change when stressed (e.g. Conner et al., 1999; O'Connor & O'Connor, 2004; Oliver & Wardle, 1999). Therefore, the findings are consistent with the theory that external eaters increase awareness of food stimuli when stressed, which could then account for increased intake in this subgroup.

The dot probe findings in Studies Three and Five did not find any significant interactions between stress condition and external eating for food word or picture bias scores. Both studies showed that high external eaters tended to avoid the food stimuli when stressed. It is difficult to explain why these findings differ from the interactions reported in the dot probe in Study Four and the Stroop task in Study Three. It has been previously suggested that the dot probe task is more open to strategic processing than the modified Stroop (Broschott et al., 1999), as the presence of two stimuli in one trial enables individuals to disengage their attention from salient stimuli. Strategic processing could explain the avoidance of food stimuli in Study Three's dot probe, as it seems plausible that high external eaters would try to generally avoid food-related stimuli to prevent overeating. However, stimulus exposure times were varied in Study Five to address this issue, so it is difficult to explain the avoidance in this final study. It is worth considering that high and low external eaters in Study Three were selected by external eating score from a larger population, whereas the median was used to group participants in Study Five. This median split method of selecting high and low external eaters coupled with a small sample size could have masked any effects. Overall the reports from the three studies are not entirely consistent. However, the results from Studies Three and Four do indicate a conscious attentional bias for snack and unhealthy food stimuli in stressed, external eaters.

The results from Study Three did not support an attentional bias mechanism for stress-induced eating in restrained eaters, as no significant interactions were reported between stress and restraint on either the dot probe or Stroop task. In addition, highly restrained individuals generally showed smaller biases towards food words than low restrained eaters. This latter finding adds to the inconsistency within previous research testing attentional biases for food stimuli in restrained eaters (e.g. Francis et al., 1997; Jansen et al., 1998). It could be the case that the scale used to measure restrained eating in the current study tends to identify individuals who are successful dieters (Ruderman, 1979), less susceptible to disinhibited eating during stress. No previous studies have tested the interaction between restrained eating and stress when investigating attentional biases for food stimuli for comparison. However, the results presented here do not support the attentional bias mechanism for stress-induced eating within restrained eaters.



Overall, the results from the three studies presented in this chapter suggested that an attentional bias mechanism could contribute towards stress-induced eating within high external eaters. Two of the presented studies showed evidence of increased vigilance towards snack and unhealthy food words in stressed, external eaters. This attentional shift would be expected to increase intake in external eaters, who are driven to eat by food cues. These findings suggest that external eaters show increased awareness of snack and unhealthy food stimuli when stressed, rather than food stimuli in general. Furthermore, this attentional shift was observed for stimuli above conscious awareness. In contrast, there was little evidence that a shift in attention could account for stress-induced intake in restrained eaters.

## CHAPTER FOUR

### THE ROLE OF CORTISOL REACTIVITY IN STRESS-INDUCED EATING

#### 4.1 Introduction

The previous chapter investigated an attentional bias mechanism of stress-induced eating in susceptible individuals, but it is also possible that an eating response to stress originates from the physiological stress response. The purpose of Study Six was therefore to explore whether individual differences in physiological stress reactivity account for differences in eating response. During a typical human response to a physical or psychological stressor, the hypothalamus releases corticotrophin releasing factor (CRF), which in turn stimulates the release of adrenocorticotrophic hormone (ACTH) from the pituitary gland, and subsequently glucocorticoids, including cortisol, from the adrenal cortex. The production of glucocorticoids stimulates the release of stored metabolic energy from the liver (gluconeogenesis), required for a behavioural 'fight or flight' response. However, a negative feedback mechanism to the hypothalamus prevents the release of further glucocorticoids and basal values are restored.

It is now becoming clear that glucocorticoids not only promote the release of stored energy, but that they also support energy intake, through feeding behaviour. Direct manipulations of cortisol levels have supported this notion. Laugero (2001) has shown that the prevention of glucocorticoid secretion in rats (e.g. following adrenalectomy) resulted in a decrease in carbohydrate intake relative to other macronutrients. In a human study, the administration of high levels of glucocorticoids was found to increase ad libitum energy intake, in particular of proteins and carbohydrates (Tataranni et al., 1996). Therefore, it appears from animal and human studies that glucocorticoids affect energy consumption, whereby a decrease in levels results in decreased intake and an increase in levels results in greater energy intake.

These studies demonstrate the effects of a direct manipulation of glucocorticoids on eating behaviour, either through a decrease or increase in glucocorticoid



concentrations. There is also evidence that the release of glucocorticoids during a normal physiological stress response is associated with food intake. Epel et al. (2001) investigated the relationship between salivary cortisol levels and eating behaviour in females following a laboratory stressor. After forty-five minutes exposure to a stress manipulation, the participants were invited to eat freely from a range of snacks. Those participants who were highly reactive to the stressor in terms of cortisol output consumed a greater amount than low cortisol reactors during stress recovery. Furthermore, the intake of sweet foods in particular was greater among the high reactors. These findings suggest that individual differences in the eating response to stress are dependent on glucocorticoid reactivity to stress, such that high cortisol reactors consume a greater amount of food than do low cortisol reactors.

Interestingly, cortisol production is related to other known moderators of stress-induced eating. Obese individuals have been found to produce greater levels of cortisol than those of normal weight, particularly those with large quantities of central, rather than peripheral, fat (Bjorntorp & Rosmond, 2000). Obese individuals frequently respond to stress by increasing food intake (e.g. Lowe & Fisher, 1983), and it is possible that high levels of cortisol secretion in the obese underlie this eating response. In fact, cortisol secretion may also be responsible for central obesity (Bjorntorp, 2001; Epel et al., 2000). The consumption of food when glucocorticoid levels are high results in a rise in insulin secretion, which in turn promotes the conversion of energy stores to fat, particularly round abdominal regions, where glucocorticoid receptors are abundant (Laugero, 2001; Strack et al., 1995).

There is also a possible link between dietary restraint and cortisol levels. McLean et al. (2001) have reported that levels of urinary cortisol over twenty-four hours were greater among women high in cognitive dietary restraint. Anderson et al. (2002) have also reported a positive relationship between restraint score and salivary cortisol. These researchers argue that the higher levels of cortisol are due to the stress of constantly monitoring food intake. However, considering the tendency for restrained eaters to increase food intake under stress, it would be interesting to

investigate any difference in overall cortisol levels or reactivity between restrained and unrestrained eaters in a stress paradigm.

Gender has also been associated with differences in cortisol reactivity. Galluci et al. (1993) found a differential secretory pattern in males and females after exposure to corticotrophin releasing hormone, where females continue to produce cortisol for a longer period than males. This prolonged exposure to cortisol following stress could contribute to a greater tendency for females to increase food intake under stress (e.g. Grunberg & Straub, 1992). Males and females also appear to react differently to different stressors. For example, Stroud et al. (2002) found that males were more reactive following achievement stressors, while females were more reactive following social rejection stressors. Similarly, Steptoe et al. (2000) reported that males and females reacted differently to different types of work challenge. Accordingly, it may be expected that males and females would differ in eating behaviour according to the nature of the stressor.

Stress reactivity may also depend on personality characteristics. Suarez et al. (1998) reported that highly hostile men showed greater cardiovascular and cortisol reactivity to an interpersonal stressor than did low hostile men. Hostility is also particularly shown to predict cardiovascular reactivity to provocative stressors (Suls & Wan, 1998). Therefore hostility may be expected to moderate stress reactivity, for interpersonal and other provocative stressors especially. There is also some evidence that extraversion influences reactivity, with introverts being generally more aroused than extraverts (Dabbs & Hopper, 1990; Stenberg et al., 1990), and introverts showing a greater startle response (Blumenthal, 2001). However, Kirschbaum et al. (1992) found no relationship between introversion score and cortisol response to social stress. Third, anxiety level may be expected to affect stress reactivity. The effect of trait anxiety is inconsistent, with some researchers reporting a greater association between pressure and salivary cortisol production for those high in trait anxiety (Schlotz et al., 2006), and others reporting lower salivary cortisol in high trait anxiety individuals in response to psychosocial stress (Jezova et al., 2004) or no difference (Bohnen et al., 1991). State anxiety has been associated with increased cortisol reactivity to the stress of public speaking (Roberts et al.,



2004), and general negative affect with salivary cortisol reactivity in a field study (Smyth et al., 1998).

The relationship between cortisol reactivity and eating behaviour could be influenced by coping style. Coping is conceptualised as involving three main strategy types (Carver et al., 1989). These are active (engaging in activities aimed at solving the problem), emotion-focused (concentrating on the emotional distress) and avoidance coping (engaging in unrelated activities). Carver et al. (1989) argue that active and emotional coping strategies are particularly effective when stressors are encountered, in tackling the source of the problem and reducing emotional distress. Bohnen et al. (1991) further suggest that emotional coping is particularly effective for regulating emotions when uncontrollable stressors arise. However, avoidance coping is seen as a less effective coping strategy, as a failure to act or solve a problem may induce helplessness (Lyne & Roger, 2000), and this form of coping has been associated with increased distress (O'Connor & O'Connor, 2003). It may be expected that engaging in active or emotional coping to everyday stressors would reduce behavioural responses to stress, such as increasing intake of snacks. Avoidance coping, however, may be associated with a greater tendency to engage in behavioural distractions from the source of the stressor, such as eating.

It is as yet unclear how glucocorticoids might affect appetite, but the appetitive effect of glucocorticoids on food intake may form part of a larger food control mechanism in the hypothalamus. Sapolsky (1998) has argued that CRF and glucocorticoids have conflicting effects on appetite, whereby the secretion of corticotrophin releasing hormone at the beginning of a stressful encounter inhibits appetite, but that the subsequent secretion of glucocorticoids stimulates appetite. This makes evolutionary sense, as energy levels would need to be replenished after a stress-induced activity, although this mechanism would not necessarily be adaptive for modern-day stressors, which are psychological in nature. Indeed, there is evidence that CRF has anorectic effects (Friedman & Halaas, 1998; Laugero, 2001); at least in the short term (Krahn et al., 1990), as Sapolsky theorised. One further implication of the proposed mechanism is that short stressors or a continuous series

of stressors would promote food intake more than a long continuous stressor, since a larger level of glucocorticoids would be secreted relative to CRF.

Dallman et al. (1994) offered an alternative food control mechanism involving complementary effects of glucocorticoids and insulin. However, both accounts argue for an appetitive role of glucocorticoids. It is unknown whether the effect of glucocorticoids directly or indirectly influences appetite, as it has close secretory links with both neuropeptide Y and leptin (e.g. Leal-Corro et al., 2001; Zakrzewska et al., 1997), which are already highly associated with appetite stimulation and intake (e.g. Strack et al., 1995). Therefore, any effects of glucocorticoids may in fact be mediated by the substrates neuropeptide Y or leptin.

The relationship between cortisol release and eating behaviour is seemingly a reciprocal one. For example, Toda et al. (2004) have investigated cortisol levels following consumption of snacks. This study showed that half an hour after eating snacks, there was an increase in salivary cortisol. However, this was further increased an hour after eating, and levels were not comparable to baseline until ninety minutes post baseline. The effect of eating on subsequent stress reactivity has also been investigated: Gonzalez-Bono (2002) reported that consumption of glucose causes greater salivary cortisol reactivity following the TSST, forty-five minutes after consumption of the glucose solution. Eating in general appears to raise cortisol levels, and may, if the food is rich in glucose, also affect reactivity to a stressor. Therefore it is important for investigations of the stress and intake to establish whether participants have recently eaten.

A further methodological issue concerns the measurement of cortisol reactivity. Two main measures of reactivity are the area under the curve (AUC) and peak response from baseline. With the AUC method, cortisol measures are taken during baseline, stress period and recovery, plotted, and the area under the curve calculated (Pruessner et al., 2003). This methodology is often advantageous to the researcher because it allows the study of recovery rate as well as an initial response (Ramsey & Lewis, 2003). The alternative measure, peak response, simply requires the researcher to measure the change in cortisol from baseline to peak response. The advantage of this method is that the participant is required to be present in the



laboratory and provide salivary or blood samples for a shorter period of time. The peak response will be achieved within twenty to thirty minutes following a laboratory psychological stressor (Kirschbaum & Hellhammer, 1989). In contrast, the subject may need to provide samples for a further hour after the stressor for levels to return to baseline, if the AUC is plotted (e.g. Kirschbaum et al., 1993).

Research so far has addressed the link between glucocorticoids (including cortisol) and eating in animals, by examining the effects of administration, or prevention of secretion, on food intake. Human studies have looked at the effect of glucocorticoids on macronutrient intake in a laboratory setting, and the difference in food consumption between high and low reactors following a laboratory stressor. However, studies have not looked at how high and low cortisol reactors behave outside of the laboratory, in response to real-life stressors. To fully understand people's eating behaviour in response to stress, and to test the importance of the role of glucocorticoids in controlling everyday eating behaviour, it is necessary to further examine this link within a naturalistic setting. Research has also highlighted the possible associations between well-established moderators of stress-induced eating, such as obesity and dietary restraint, and cortisol levels. However, there have been no investigations of differences between subgroups in response to stress, or of the importance of the type of stress. Therefore, the aims of Study Six were to investigate the hypothesis that cortisol reactivity is related to food intake, in both the laboratory and field settings, and to test its interaction with well-established moderators of stress-induced eating.

#### **4.2 Study Six: Relationship between cortisol reactivity and food intake in adult women**

Study six aimed to test whether cortisol reactivity to stress could predict the amount and type of food consumed, in both a laboratory and natural setting. Previous studies have found sex differences in cortisol response to stress, where males are more reactive than females (e.g. Kudielka & Kirschbaum, 2005). To eliminate stress reactivity differences due to sex, and since females may be more susceptible to stress-induced eating (e.g. Grunberg & Straub, 1992), only females were included in the present study. Women completed a stress procedure in a laboratory, and were then invited to eat freely from a range of snacks. The participants also completed

diaries for two weeks recording daily hassles and snack intake. Hierarchical multivariate linear modelling (HMLM; Raudenbush et al., 2004) was conducted to test the relationship between daily hassles and intake from the diaries. The use of hierarchical modelling allowed the effects of daily variations in stress, and higher order predictors of eating style and cortisol reactivity to be tested.

#### **4.2.1 Method**

##### ***Participants***

Participants were recruited for a ‘women and eating’ study, through the University of Leeds website and through adverts placed in the Leeds Council Bulletin. Fifty five women aged between 25 and 45 completed the lab procedure of the study. Of this number, four did not return both diaries, and one person did not produce enough saliva for analysis. This left a total of 50 women who completed the whole study. The mean age was 33.96 years (SD=6.18), and mean BMI was 23.76 (SD=4.70). Five women were currently on a diet to lose weight (10% sample). The study used exclusion criteria based on factors that could affect cortisol levels. Participants were excluded if they had previously been diagnosed with a neuroendocrine or metabolic disorder, diabetes, or had a history of eating disorders or depression (Epel et al., 2001). Women who were currently taking oral contraceptives or were post-menopausal were also excluded (Kirschbaum & Hellhammer, 1989; Pruessner et al., 1997). Although there is evidence that cortisol levels can be raised around the luteal phase of the menstrual cycle (Kirschbaum et al., 1999), cycle phase was left randomised. The participants were asked to avoid exercise and alcohol consumption on the day of laboratory testing. They were also asked not to eat for an hour and a half before the laboratory visit, or to smoke for an hour before testing due to associated rises in cortisol (Morgan et al., 2004). One participant had smoked a cigarette in the hour beforehand, but was not excluded. The participants were paid twenty pounds for completing all parts of the study.

##### ***Laboratory measures***

At the start of the laboratory visit, the participants’ height and weight were recorded. The participants also provided details of their age, whether they had eaten in the last



hour and a half, whether they had smoked in the last hour and when they had got up that morning.

The participants completed a battery of questionnaires during the laboratory visit. This included the restraint, emotional and external eating scales of the Dutch Eating Behaviour Questionnaire (DEBQ; Van Strien et al., 1986a). The current sample showed high internal reliability for restraint (Cronbach's  $\alpha=0.89$ ), emotional eating ( $\alpha=0.92$ ) and external eating ( $\alpha=0.84$ ). The disinhibition scale of the Three Factor Eating Questionnaire (TFEQ; Stunkard & Messick, 1985) and the rigid and flexible restraint scales of Westenhoefer et al. (1999) were also completed by participants. In the current sample, the rigid control and flexible control scales showed satisfactory reliability ( $\alpha=0.73$  and  $0.75$  respectively), and disinhibition showed good internal reliability (Cronbach's  $\alpha=0.84$ ). The Eating Attitudes Test was administered to test whether the participants had disordered eating patterns (EAT-26; Garner et al., 1982). This 26-item questionnaire aims to measure tendencies towards anorexia and bulimia, and has been shown to possess good reliability and validity (Garner et al., 1982). In the current sample, no participants scored above the cut off point of 20 for disordered eating.

The 60-item conscientiousness scale and 10-item emotional stability, extraversion and agreeableness scales from the International Personality Item Pool (IPIP; Goldberg, 1999) were administered. The conscientiousness, emotional stability and extraversion scales showed high internal reliabilities in the current sample ( $\alpha=0.96$ ,  $0.91$  and  $0.84$  respectively). However, the agreeableness scale showed slightly low internal reliability in this sample ( $\alpha=0.67$ ). Hostility was measured using the Cook-Medley (1954) Hostility scale. This 50-item scale possessed satisfactory reliability in the current sample (Cronbach's  $\alpha=0.78$ ). The methods of coping scale (COPE; Carver et al., 1989) was administered to test usual coping strategies to stress. The 53-item COPE scale measures tendency for 15 coping styles, including active coping, restraint and religion coping strategies, and has been validated by Carver et al. (1999). The factor structure of the COPE has been reassessed by Lyne and Roger (2000), to produce a three-factor structure of active, emotion-focused and avoidance coping strategies. The Multidimensional Scale of Perceived Social Support (MSPSS; Zimet et al., 1988) was administered.

This 12-item scale measures perceived support from significant others, friends and family, and has been shown to possess high reliability and validity (Zimet et al., 1988). In the current sample, the scale also possessed high internal reliability (Cronbach's  $\alpha=0.88$ ). The Multidimensional Perfectionism Scale (MPS, Hewitt & Flett, 1991) was administered to test self-oriented and socially prescribed perfectionism. In the current sample, both self-oriented perfectionism and socially prescribed perfectionism showed high internal reliability (alphas=0.90 and 0.81 respectively).

The participants also completed the short-form of the state anxiety scale from the Spielberger State-Trait Anxiety Inventory (STAI; Marteau & Bekker, 1992) before and after the stress manipulation. The participants also rated how stressful the manipulation had been, how much effort they had put into the tasks and how in control they had felt, using seven-point anchored scales from 'not at all' to 'extremely'. Hunger was measured at three time points in the laboratory- at baseline, and after 30 minutes and 70 minutes in the laboratory. The participant circled how hungry she felt on a seven-point scale from 'not at all' to 'extremely' at each time point. Each participant also rated liking for the test foods (embedded in a list) on a five-point scale from 'strongly dislike' to 'strongly like'.

### ***Stress protocol***

The stress manipulation was based on the Trier Social Stress Test (Kirschbaum et al., 1993). The procedure lasted a total of fifteen minutes. For the first five minutes, the women were asked to prepare a five-minute presentation of their opinion on a controversial topic, for later assessment by psychologists who were experts in body language (as used in Studies Three to Five). After five minutes, the participant was asked to perform the presentation for five minutes in front of the experimenter and a videocamera; however, the performance was not actually recorded or assessed. The participant was prompted to continue if the presentation stopped for any length of time, until a total of five minutes had passed. The participant was then asked to count backwards serially in thirteens from the number 1022 for five minutes, while the experimenter kept time. If an incorrect response was made, the participant was required to restart the subtraction from the beginning. Stress protocols involving



both an assessment and mathematical component have been shown to be most effective in inducing cortisol reactivity (Dickerson & Kemeny, 2004).

### ***Cortisol measurements***

The participants provided salivary samples of cortisol, using salivette tubes (Sarstedt, UK). Salivary samples provide a non-invasive measure of free, bio-available cortisol levels (DeWeerth et al., 2003; Kirschbaum & Hellhammer, 1989). The salivette contains a cotton dental roll inside a plastic tube, which the participant is required to place in the mouth for 30 to 45 seconds before replacing in the tube. The salivettes were frozen at  $-20^{\circ}\text{C}$  on the same day, to preserve sample stability as well as possible (Groschl et al., 2001). After defrosting and spinning, the saliva samples were tested using a fluorescence immunoassay using an autodelphia kit.<sup>1</sup>

### ***Field measures***

The participants completed two weekly diaries over two consecutive weeks. Each day they were asked to record their mood using the shortened Positive and Negative Affect Scale (PANAS; MacKinnon et al., 1999). They recorded any hassles that they had experienced, and rated the intensity of these hassles on a scale of 0 to 4, from ‘not at all’ to ‘very much’. The participants were then required to record any snacks that they had consumed between meals (see Appendix 4.1 for daily diary measures). The participants were asked to complete their daily entries at the end of each day, and to return each diary by post as soon as it was completed, using a pre-paid, addressed envelope. Please refer to Appendix 4.2 for ethics approval.

### ***Procedure***

All participants were tested in the laboratory during the afternoon, to control for the waking cortisol response (e.g. Pruessner et al., 1997), and because cortisol reactivity is greater in the afternoon (Kirschbaum & Hellhammer, 1989). Upon arrival at the laboratory, the participant was provided with a study information sheet and study consent form. The participant was informed that the study aimed to investigate eating patterns in women. After providing consent, the participant was measured and weighed, then provided the first baseline saliva sample. The participant was

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<sup>1</sup> Analysis of cortisol was conducted by Unilever, in Colworth.

asked to relax for fifteen minutes, and was provided with magazines. A Classical Chillout compact disc (Circa Records Ltd, 2001) was played in the room to aid relaxation. After fifteen minutes, a second baseline saliva sample was taken. The 15-minute stress induction procedure was then conducted. After the stress procedure, a third saliva sample was taken. The participant was asked to complete the questionnaire battery for forty minutes. During this time, four more saliva samples were taken, at ten-minute intervals (see Table 4.1).

**Table 4.1 Timetable of laboratory events**

| <i>Time (mins)</i> | <i>Period</i> | <i>Activity</i>  | <i>Sampling (mins)</i>   |
|--------------------|---------------|--|--|
| -15 to 0           | Pre-stress    | Completion of consent form, information sheet, state anxiety scale, relaxing music         | 1. t = -15<br>2. t = 0<br>(Total=2)  |
| 0-15               | Stress        | Stress protocol- 5 mins preparation, 5 minutes speech, 5 minutes arithmetic                | (Total=0)  |
| 15-55              | Post-stress   | Completion of state anxiety questionnaire and post-task ratings, Battery of questionnaires | 3. t = 15<br>4. t = 25<br>5. t = 35<br>6. t = 45<br>7. t = 55<br>(Total=5) |
| 55-85              | Recovery      | Given snacks and relaxing music  | 8. t = 85<br>(Total=1)   |

After completing the questionnaire battery, the participant was led into a different room, and asked to relax again for twenty minutes, while listening to the classical chillout CD. Each participant was provided with four types of snack representing high and low fat and sweet and savoury snack types, and invited to eat as much as she wished (see Appendix 4.3 for composition of snack foods). The snack selection included Bassett's Jelly Babies (sweet, low fat), Pringles Original flavour crisps (savoury high fat), Cadbury's dairy milk chocolate (sweet, high fat) and Schar grissini breadsticks (savoury, low fat). The bowls of food were weighed before and afterwards to the nearest gram, using Salter 'Add and Weigh' electronic scales. After twenty minutes, the participant completed a final saliva sample. Although the participant had eaten, which may contaminate the sample, the eighth sample was taken as a pretext for keeping the participant in the laboratory for another twenty minutes. The participant was then provided with the two diaries (with own



instructions) in freepost envelopes and contacted for debriefing after receipt of the second diary. Table 4.1 shows the laboratory protocol.

### ***Statistical analysis***

Cortisol reactivity was determined using the difference between mean baseline cortisol level and maximum level after the stressor (between 10 and 40 minutes after the start of the stress protocol)<sup>2</sup>. Those individuals who increased in cortisol levels were classified as high reactors, while those who showed no change or decreased in levels from baseline were classified as low reactors. Independent groups t-tests were conducted to test whether high and low cortisol reactors differed on total intake of snacks, and intake of sweet and savoury and high and low fat snacks. For the diary component of the study, hierarchical linear modelling was conducted to test the relationship between daily hassles and snack intake, and the interaction with cortisol reactivity status.

## **4.2.2 Results**

### **4.2.2.1 Stress reactivity and intake in the laboratory**

#### ***Stress manipulation***

The stressfulness ratings of the stress procedure ranged from 1 to 7 on the 7-point scale, with a mean of 4.78 (SD=1.43), indicating that the stressor was stressful, but not extremely stressful. The mean state anxiety level was 13.94 (SD=3.32) before the stress manipulation, and 16.76 (3.68) after the manipulation. A repeated measures t-test indicated that this difference was significant ( $t(49)=-4.96$ ,  $p<0.001$ ). Therefore the stress manipulation was successful in increasing anxiety.

#### ***Cortisol reactivity***

Cortisol reactivity in the laboratory was measured by taking the difference between the average of the two baseline samples and the peak response, between ten and forty minutes following the start of the stress procedure. The participants showed an average cortisol increase of 1.36nmol/L (SD=3.77), but values ranged from -3.39 to

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<sup>2</sup> Area under the curve with respect to the ground (Pruessner et al., 2003) was also calculated for cortisol values, but subsequent analysis did not show different results from analysis with peak reactivity values, so this analysis is not reported here.

+13.43, indicating that some participants showed a decrease in cortisol following the baseline samples. Previous studies have shown an average cortisol increase of approximately 7nmol/L (Kirschbaum et al., 1992; Kudielka et al., 2004), therefore the average reactivity was lower in the current study. 26 sample members showed an increase in cortisol levels, while 23 showed a decrease, and one participant showed no change. Therefore, 26 participants were classified as high reactors using this measure, and 24 as low reactors<sup>3</sup>. High reactors showed an average cortisol increase of 3.69nmol/L (SD=3.92), while low reactors showed an average cortisol increase of -1.18nmol/L (SD=0.85). The high and low reactors did not differ in average baseline values ( $t(48)=0.08$ , n.s.), but did significantly differ in reactivity from baseline ( $t(48)=-6.18$ ,  $p<0.001$ ).

### ***Differences in stress measures between high and low reactors***

There were no significant differences between high and low cortisol reactors in either stress ratings of the manipulation ( $t(48)=-0.93$ , n.s.), or reported effort put into the tasks ( $t(48)=-0.50$ , n.s.). However, the reactor groups did differ in state anxiety following the stress manipulation ( $t(48)=-3.11$ ,  $p<0.01$ ), indicating that the high reactors had a greater anxiety rating following the stressor than did low reactors. Despite this difference, the low reactor group did still show a significant difference in anxiety ratings pre and post the stress manipulation ( $t(23)=-2.22$ ,  $p<0.05$ ).

### ***Differences in personality between high and low reactors***

High and low reactors did not differ on either age or BMI. They also did not differ in social support, hostility, perfectionism, conscientiousness, active, emotional or avoidance coping, emotional stability or agreeableness. However, there was a significant difference in extraversion scores between the high and low reactors ( $t(48)=2.56$ ,  $p<0.05$ ), with the low reactors scoring more highly in extraversion than high reactors. There were no significant Pearson's correlation coefficients between any of the personality measures and peak cortisol reactivity.

### ***Differences in eating style measures between high and low reactors***

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<sup>3</sup> Although the low reactors showed no cortisol reaction to the stressor, groups were categorised as 'high and low reactors' rather than 'reactors and non-reactors' to be consistent with Epel et al.'s (2001) terminology



The high and low peak cortisol groups did not differ along any of the eating style dimensions. However, peak cortisol relative to baseline was significantly positively associated with emotional eating ( $r=0.43$ ,  $p<0.01$ ), external eating ( $r=0.31$ ,  $p<0.05$ ), disinhibition ( $r=0.44$ ,  $p<0.01$ ) and rigid control scores ( $r=0.37$ ,  $p<0.01$ ).

### ***Hunger and liking of foods between high and low reactors***

There were no differences between the reactor groups in hunger ratings at any of the three hunger measurement time-points (at the start of the test, after stress manipulation and just before snacks were provided; all n.s.). However, the third hunger rating was significantly correlated with the number of grams consumed ( $r=0.50$ ,  $p<0.01$ ), so hunger rating was controlled for in subsequent analysis. Liking for the test foods did not differ between the reactor groups, except for the liking for breadsticks, which was greater in the high reactor group ( $t(48)=-2.39$ ,  $p<0.05$ ). The overall liking rating for the test foods was positively related to the amount consumed ( $r=0.31$ ,  $p<0.05$ ), and so liking for the foods was also controlled in all analyses.

### ***Intake differences between high and low reactors***

The amount eaten ranged from 0 to 200g of the test foods, with a mean of 62.08g (SD=52.10). The number of kilocalories consumed ranged from 0 to 903.90kcal, with a mean of 293.12kcal (SD=242.12). Only one participant consumed no snacks. Table 4.2 shows the mean amounts of each type of snack consumed in kcals, by high and low reactors. The kcals from chocolate and crisps were combined to give the total kcals of high fat foods. Using the same procedure, the total kcals were calculated for low fat (breadsticks and jelly babies), sweet (chocolate and jelly babies) and savoury snacks (crisps and breadsticks).

Table 4.2 shows that the low reactors consumed a greater amount in total kcals than the high reactors, with a mean intake of 349.96kcals in the low reactors, and 240.65kcals in high reactors. However, ANCOVA revealed no significant differences in the kcals consumed between the high and low reactor groups. The high reactors consumed smaller amounts of crisps and jelly babies than low reactors, but consumed a greater amount of breadsticks and a similar amount of chocolate. ANCOVA revealed that high and low reactors only differed significantly in the number of kcals consumed from jelly babies ( $F(1,46)=5.43$ ,  $p<0.05$ ), where the low

cortisol group consumed a greater amount. The low reactors consumed greater amounts of high fat, low fat, sweet and savoury foods than did the high reactors, but there were no significant differences between the reactor groups.

**Table 4.2** Amounts eaten in the laboratory by high and low cortisol reactors (N=50)

| <i>Type of snack</i>          | <i>Mean amount consumed in kcals (SD)</i> |                      |
|-------------------------------|---|----------------------|
|                               | <i>Low reactors</i>                       | <i>High reactors</i> |
| Crisps (hi fat savoury)       | 143.63 (139.12)                           | 85.97 (128.82)       |
| Chocolate (hi fat sweet)      | 101.06 (104.44)                           | 101.37 (86.48)       |
| Breadsticks (lo fat savoury)  | 12.86 (20.64)                             | 14.93 (19.45)        |
| Jelly babies (lo fat sweet) * | 92.40 (112.39)                            | 38.40 (50.83)        |
| Total sweet                   | 193.47 (177.72)                           | 139.76 (109.12)      |
| Total savoury                 | 156.50 (145.85)                           | 100.89 (133.52)      |
| Total hi fat                  | 244.70 (196.73)                           | 187.33 (182.99)      |
| Total lo fat                  | 105.27 (119.25)                           | 53.32 (53.41)        |
| Total snacks                  | 349.96 (280.29)                           | 240.65 (191.45)      |

\*  $p < 0.05$

The proportions of each type of food consumed were calculated by dividing the number of kcals of each snack consumed by the total number of kcals consumed. These indices were calculated for high fat, low fat, sweet and savoury foods, as well as high fat savoury, high fat sweet, and low fat savoury and low fat sweet foods. The low cortisol reactors consumed a greater proportion of their kcals from high fat and savoury foods than high reactors, while high reactors consumed a greater proportion of low fat and sweet foods than the low reactors. However, none of these differences was significant.

### ***Relationship between eating style and intake***

Pearson's correlation coefficients were calculated between the eating style measures and the kcals and proportions of the snacks consumed. There were no significant correlations between any of the eating style measures and the kcals consumed from each food, or proportions of each snack type consumed. The high cortisol reactor



group was further divided using the median value (2.83nmol/L), to create very high reactors and high reactors. Within very high reactors, Pearson's Correlation Coefficients revealed significant positive associations between the total number of kcals consumed and dietary restraint ( $r=0.60$ ,  $p<0.05$ ), rigid control ( $r=0.56$ ,  $p<0.05$ ) and flexible control restraint ( $r=0.59$ ,  $p<0.05$ ). The coefficients indicated that as restraint scores increased within the very high reactors, so did the total number of kilocalories consumed. The number of kcals of savoury food consumed was significantly associated with restraint ( $r=0.63$ ,  $p<0.05$ ), emotional eating ( $r=0.61$ ,  $p<0.05$ ), external eating ( $r=0.66$ ,  $p<0.05$ ) and disinhibition ( $r=0.64$ ,  $p<0.05$ ). Therefore, the amount of savoury food consumed increased as restraint, emotional and external eating and disinhibition increased in the very high reactors. However, none of the eating style measures significantly correlated with the total kcals consumed or the kcals from savoury food in either the low reactors, or the lower band of the high reactors (all n.s.).

#### ***Interaction between eating style and reactivity in predicting intake***

To test the interactions between eating style and stress reactivity in predicting snack intake, interaction terms were created between peak cortisol response and restraint, emotional eating, external eating and disinhibition (Baron & Kenny, 1986), and forced entry hierarchical regression conducted. The total number of kcals consumed was entered as an outcome variable. Hunger prior to eating, liking for the test foods, BMI, peak cortisol level, restraint, emotional eating, external eating and disinhibition were entered as predictors in the first block of variables, and the interaction terms between reactivity from baseline and eating style were entered in the second block of predictors. The model was significant with the first block of predictors ( $F(8,41)=4.75$ ,  $p<0.01$ ), with the significant predictors being hunger ( $\beta=0.56$ ,  $p<0.01$ ) and BMI ( $\beta=0.31$ ,  $p<0.05$ ). The coefficients indicated that as BMI and hunger increased, so did the total number of kcals consumed. The addition of the interaction terms did not improve the predictive power of the model ( $F_{\text{change}}(4,37)=1.81$ , n.s.).

#### **4.2.2.2 Stress reactivity and intake in the field**

The relationship between stress and snack intake in the field was assessed using hierarchical multivariate linear modelling from the diary data, as in Study Two (see

2.3 for the advantages of hierarchical linear modelling). The two weekly diaries were combined to create fourteen consecutive person-days for each participant. As there were 50 participants, 700 person-days were created. Daily affect, number of hassles and number of snacks consumed were entered in a level 1 (within-person) file, and eating style, reactor status and the personality variables were entered into a level 2 (between-person) file. The program HLM6 (Raudenbush et al., 2004) was used to analyse the data. In all analyses, an unrestricted model best fitted the data.

***Relationship between daily affect, hassles and snack intake***

The number of daily hassles ranged from 0 to 5, with a mode of 1 hassle. The number of hassles was positively skewed, so this variable was recoded into a high or low number of hassles, with 0 or 1 hassles coded as low, and 2 or more coded as high. This represented the most even division of low and high numbers of hassles, with 65.7% days coded as low number of hassle days, and the remaining 34.3% coded as high hassle days. The intensities for each hassle (each rated on a five-point scale) were summed on each day, to give a total daily hassle intensity score. Hassle intensity scores ranged from 0 to 16. The intensity of hassles was also positively skewed, so this variable was dichotomised into high and low groups, with intensity score of 0 to 2 coded as low, and 3 to 16 as high. 47.1% days were coded as low intensity hassles and 52.9% as high intensity hassles, using these boundaries. Because the number and intensity of hassles had been dichotomised, both these variables were entered as uncentred variables in the multivariate models. The number of daily snacks consumed ranged from 0 to 6, with a mean of 1.84 snacks per day.

The effect of the number and intensity of daily hassles on overall snack intake was tested using a level one model, with the number and intensity of hassles as predictors. This model is expressed in the equation:

$$Y_i = \beta_0 + \beta_1 + \varepsilon_i$$

Where  $Y_i$ =the outcome variable of the number of daily snacks,  $\beta_0$ =the intercept,  $\beta_1$ =the slope for the level one predictor variable and  $\varepsilon_i$ =the random error term.



Each level one predictor variable (number of hassles, intensity of hassles, negative affect and positive affect) was entered individually into the equation, rather than all variables being entered simultaneously. The number of hassles was significantly associated with the number of snacks consumed ( $\beta=0.32$ ,  $t=3.76$ ,  $p<0.01$ ), where a greater number of hassles was associated with increased snack intake. The relationship between hassle intensity and snack intake was also significant ( $\beta=0.24$ ,  $t=3.06$ ,  $p<0.01$ ), showing that the number of snacks increased with a greater intensity of hassles. Negative affect was also associated with daily snack intake ( $\beta=0.04$ ,  $t=3.15$ ,  $p<0.01$ ), but daily positive affect score was not ( $\beta=0.001$ ,  $t=0.12$ ,  $p=0.91$ ), indicating that daily snack intake increased with negative affect score but was unrelated to positive affect score.

### ***Relationship between daily hassles and type of snack intake***

The reported snacks were categorised into different snack types using the categories from Study One. These categories were fruit, sweets and chocolate, crisps and nuts and biscuits and cakes. The first level one model was used to test the number of each type of snack consumed in response to the number and intensity of hassles. This model was represented by the equation:

$$Y_i = \beta_0 + \beta_1 + \varepsilon_i$$

where  $Y_i$ =the within-person variations in the number of each type of snack (fruit, sweets/chocolate, crisps/nuts, biscuits/cakes),  $\beta_0$ =the intercept,  $\beta_1$ =the slope estimate for the level one predictor variable (number or intensity of hassles) and  $\varepsilon_i$ =the random error term.

The number and intensity of hassles were entered individually as level one predictor variables. The number of daily hassles was significantly associated with the number of fruit snacks ( $\beta=0.10$ ,  $t=2.08$ ,  $p<0.05$ ), and the number of sweets and chocolates ( $\beta=0.09$ ,  $t=2.11$ ,  $p<0.05$ ), but not related to the intake of crisps and nuts ( $\beta=0.03$ ,  $t=1.00$ ,  $p=0.32$ ) or biscuits and cakes ( $\beta=0.001$ ,  $t=0.02$ ,  $p=0.98$ ). The coefficients indicated that intake of fruit and sweets and chocolate increased with a greater number of hassles. However, the intensity of hassles was not associated with the number of fruit snacks ( $\beta=0.05$ ,  $t=1.14$ ,  $p=0.26$ ), sweets and chocolates ( $\beta=0.06$ ,

$t=1.56$ ,  $p=0.13$ ), crisps and nuts ( $\beta=0.01$ ,  $t=0.25$ ,  $p=0.80$ ) or biscuits and cakes ( $\beta=0.04$ ,  $t=1.14$ ,  $p=0.26$ ).

### ***Relationship between hassle type and snack intake***

The reported hassles were coded into hassle types using the categories devised in Study One (based on frequently reported hassles and stressor categories from the literature). These hassle types were: physical, ego threatening, interpersonal, work-related, time-related and chores. The hassle types were not considered mutually exclusive, and many reported hassles fitted into more than one category. The categorisation of hassles was conducted by discussion with two independent raters. The number of each daily hassle type was highly positively skewed for all categories, so the variables were recoded into the presence/absence of each of the hassle types. Therefore, if a type of hassle was reported, it was coded as present. This presence/absence categorisation dichotomised the days most evenly within each of the different hassles type.

The relationship between the presence/absence of each hassle type and the number of daily snacks consumed was tested using the initial level one model:

$$Y_i = \beta_0 + \beta_1 + \varepsilon_i$$

In this instance,  $Y_i$ =the within-person variations in the number of snacks consumed,  $\beta_0$ =the intercept term,  $\beta_1$ =the slope estimate for the level one predictor variable (presence/absence of each hassle type) and  $\varepsilon_i$ =the error term.

Each hassle type was entered individually as an uncentred variable. Table 4.3 shows the relationships between each of the hassle types and snack intake.

Table 4.3 shows that the presence of physical, time-related and household chore hassles was unrelated to the number of daily snacks consumed. However, the numbers of ego threatening, interpersonal and work-related hassles were all positively related to the intake of snacks, where the presence of each was associated with a greater intake.



**Table 4.3 Relationship between presence of hassle types and the number of daily snacks**

| <i>Hassle type predictor</i> | <i>Number of snacks</i> |      |         |
|------------------------------|-------------------------|------|---------|
|                              | $\beta$                 | SE   | t-value |
| Physical                     | 0.05                    | 0.11 | 0.49    |
| Ego threatening              | 0.34                    | 0.13 | 2.68*   |
| Interpersonal                | 0.30                    | 0.09 | 3.50**  |
| Work-related                 | 0.21                    | 0.09 | 2.38*   |
| Time-related                 | -0.20                   | 0.11 | -1.88   |
| Household chores             | 0.05                    | 0.09 | 0.61    |

\* p<0.05      \*\*p<0.01

***Moderating effects of eating style on snack intake with hassles***

To test whether the eating style variables predicted snack intake or moderated the relationship between the number of hassles and snack intake, these variables were added individually to the original equation, with the number of hassles:

$$Y_{ij} = \beta_{0j} + \beta_{1j} + \varepsilon_{ij}$$

where  $Y_{ij}$  is the total number of snacks,  $\beta_{0j}$ =the intercept for the eating style variable,  $\beta_{1j}$ =the coefficient for the number of hassles at the eating style unit and  $\varepsilon_{ij}$ =the random error for level one units within the level two units. Table 4.4 shows the effects of each eating style variable and its cross-level interaction with the number of hassles to predict the intake of snacks.

Table 4.4 shows that the total number of snacks consumed was associated with restraint, emotional eating, external eating and disinhibition scores. In all cases, greater scores on the eating style variables were associated with a greater intake of snacks, regardless of the number of hassles. However, none of the eating style variables significantly interacted with the number of hassles to relate to snack intake. To test the relative significance of the eating style measures on snack intake, they were all entered simultaneously into the model:

$$Y_i = \beta_0 + \beta_1 + \beta_2 + \beta_3 + \beta_4 + \varepsilon_i$$

Where  $Y_i$ =the within-person variations in the number of snacks consumed,  $\beta_0$ =the intercept term for the number of hassles,  $\beta_1$ =the slope estimate for dietary restraint,  $\beta_2$ =slope estimate for emotional eating,  $\beta_3$ =slope estimate for the predictor external eating,  $\beta_4$ =slope estimate for the predictor disinhibition and  $\varepsilon_i$ =the error term.

**Table 4.4 Interactions between eating style and number of hassles in predicting the number of snacks consumed**

| <i>Independent moderators</i>  | <i>Predictor</i>            | <i>Number of snacks</i> |      |         |
|--------------------------------|-----------------------------|-------------------------|------|---------|
|                                |                             | $\beta$                 | SE   | t-value |
| <i>Restraint</i>               | Number of hassles           | 0.24                    | 0.09 | 2.84**  |
|                                | Restraint                   | 0.07                    | 0.02 | 3.33**  |
|                                | Restraint * hassles         | 0.001                   | 0.01 | 0.11    |
| <i>Emotional eating</i>        | Number of hassles           | 0.31                    | 0.09 | 3.61**  |
|                                | Emotional eating            | 0.05                    | 0.02 | 3.48**  |
|                                | Emotional*hassles           | -0.01                   | 0.01 | -1.40   |
| <i>External eating</i>         | Number of hassles           | 0.32                    | 0.09 | 3.77**  |
|                                | External eating             | 0.06                    | 0.02 | 2.42*   |
|                                | External*hassles            | -0.02                   | 0.01 | -1.13   |
| <i>Disinhibition</i>           | Number of hassles           | 0.30                    | 0.09 | 3.53**  |
|                                | Disinhibition               | 0.11                    | 0.04 | 2.95**  |
|                                | Disinhibition*hassles       | -0.02                   | 0.02 | -0.82   |
| <i>Simultaneous moderators</i> | Number of hassles           | 0.21                    | 0.09 | 2.54*   |
|                                | Restraint, $\beta_1$        | 0.04                    | 0.22 | 1.96    |
|                                | Emotional eating, $\beta_2$ | 0.06                    | 0.03 | 2.08*   |
|                                | External eating, $\beta_3$  | 0.01                    | 0.03 | 0.31    |
|                                | Disinhibition, $\beta_4$    | -0.06                   | 0.07 | -0.78   |

\*p<0.05

\*\*p<0.01

The second part of Table 4.4 shows that only emotional eating score remained a significant predictor, after controlling for the other eating style variables ( $\beta=0.06$ ,  $t=2.08$ ,  $p<0.05$ ).



***Moderating effect of cortisol reactivity on the relationship between hassles and snack intake***

The effect of cortisol reactivity and its cross-level interaction with the number of hassles in predicting snack intake was tested by entering the level two predictor of peak cortisol reactivity and the level one predictor of the number of hassles into the model:

$$Y_{ij} = \beta_{0j} + \beta_{1j} + \varepsilon_{ij}$$

Where  $Y_{ij}$  represented the number of snacks,  $\beta_{0j}$  represented the intercept for the level two predictor (peak reactivity),  $\beta_{1j}$  was the regression coefficient for the number of hassles at each cortisol reactivity unit, and  $\varepsilon_{ij}$  the random error for the number of hassles within the cortisol reactivity units.

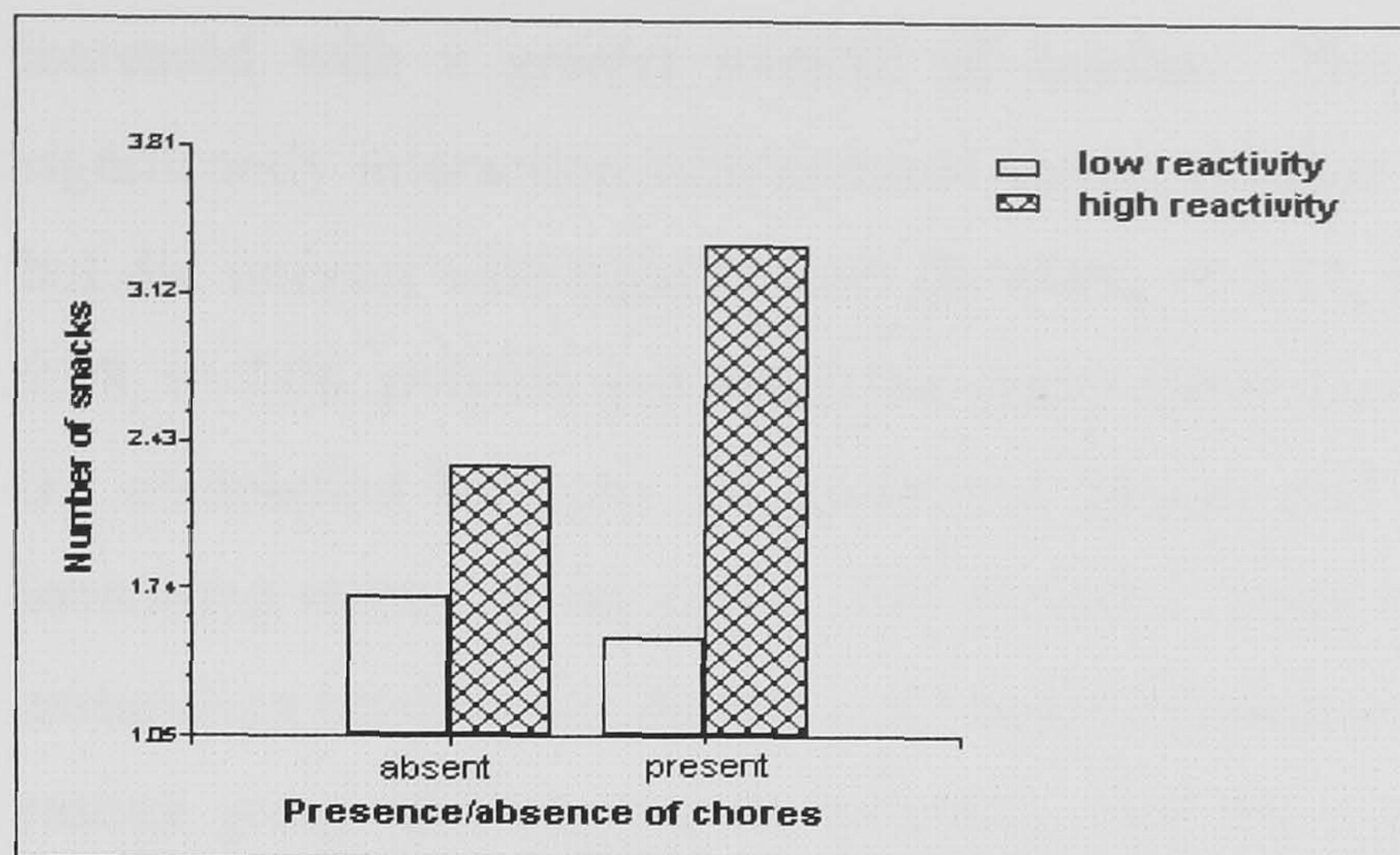
Peak reactivity was significantly related to the number of snacks consumed ( $\beta=0.11$ ,  $t=2.60$ ,  $p<0.05$ ), indicating that a greater number of snacks were consumed as peak cortisol reactivity increased. However, peak reactivity did not interact with the number of hassles to predict the number of snacks ( $\beta=-0.03$ ,  $t=-1.35$ ,  $p=0.18$ ). The presence/absence of each hassle type was substituted into the equation, to replace the number of hassles. The same model was used:

$$Y_{ij} = \beta_{0j} + \beta_{1j} + \varepsilon_{ij}$$

In this instance,  $Y_{ij}$ =the number of snacks,  $\beta_{0j}$ =represented the intercept for the level two predictor (peak reactivity),  $\beta_{1j}$ =the regression coefficient for presence/absence of each hassle type at each cortisol reactivity unit, and  $\varepsilon_{ij}$ =the random error for the presence of each hassle type within the cortisol reactivity units.

The presence or absence of each hassle type was entered individually, rather than all hassle types being entered simultaneously. Cortisol reactivity interacted with the presence of household chore hassles to relate to the total number of snacks consumed ( $\beta=0.07$ ,  $t=3.12$ ,  $p<0.01$ ). The positive coefficient indicated that the relationship between the presence of chores and snack intake was strengthened as reactivity increased. This interaction is shown in Figure 4.1.





**Figure 4.1 Relationship between presence of chore hassles and snack intake in high and low reactors**

Figure 4.1 shows that high reactors consumed a greater number of snacks when chore hassles were reported, while low reactors showed little change in snack intake with reported chore hassles.

***Relationship between hassles and snack intake and moderating role of eating style in low and high cortisol groups separately***

To test whether the relationship between hassles and snack intake differed between the low and high cortisol reactors, the same hierarchical modelling was also conducted separately for the two groups.

Within the low reactors, no association was found between the number of daily hassles and overall snack intake ( $\beta=0.01$ ,  $t=0.14$ , n.s.). There was also no significant association between the intensity of hassles and overall snack intake ( $\beta=-0.14$ ,  $t=-1.84$ , n.s.). The eating style variables (restraint, emotional eating, external eating, disinhibition, flexible control and rigid control restraint) did not interact with the number of hassles to predict snack intake (all  $p>0.05$ ). Rigid control restraint significantly interacted with the intensity of hassles in low reactors to predict snack intake ( $\beta=-0.08$ ,  $t=-2.25$ ,  $p<0.05$ ), indicating that the association between hassle intensity and snack intake weakened with increasing rigid control. None of the other eating style variables interacted with hassle intensity in low reactors (all  $p>0.05$ ).

In the high reactors, there was a significant association between the number of hassles and snack intake ( $\beta=0.39$ ,  $t=3.96$ ,  $p<0.01$ ), indicating that snack intake



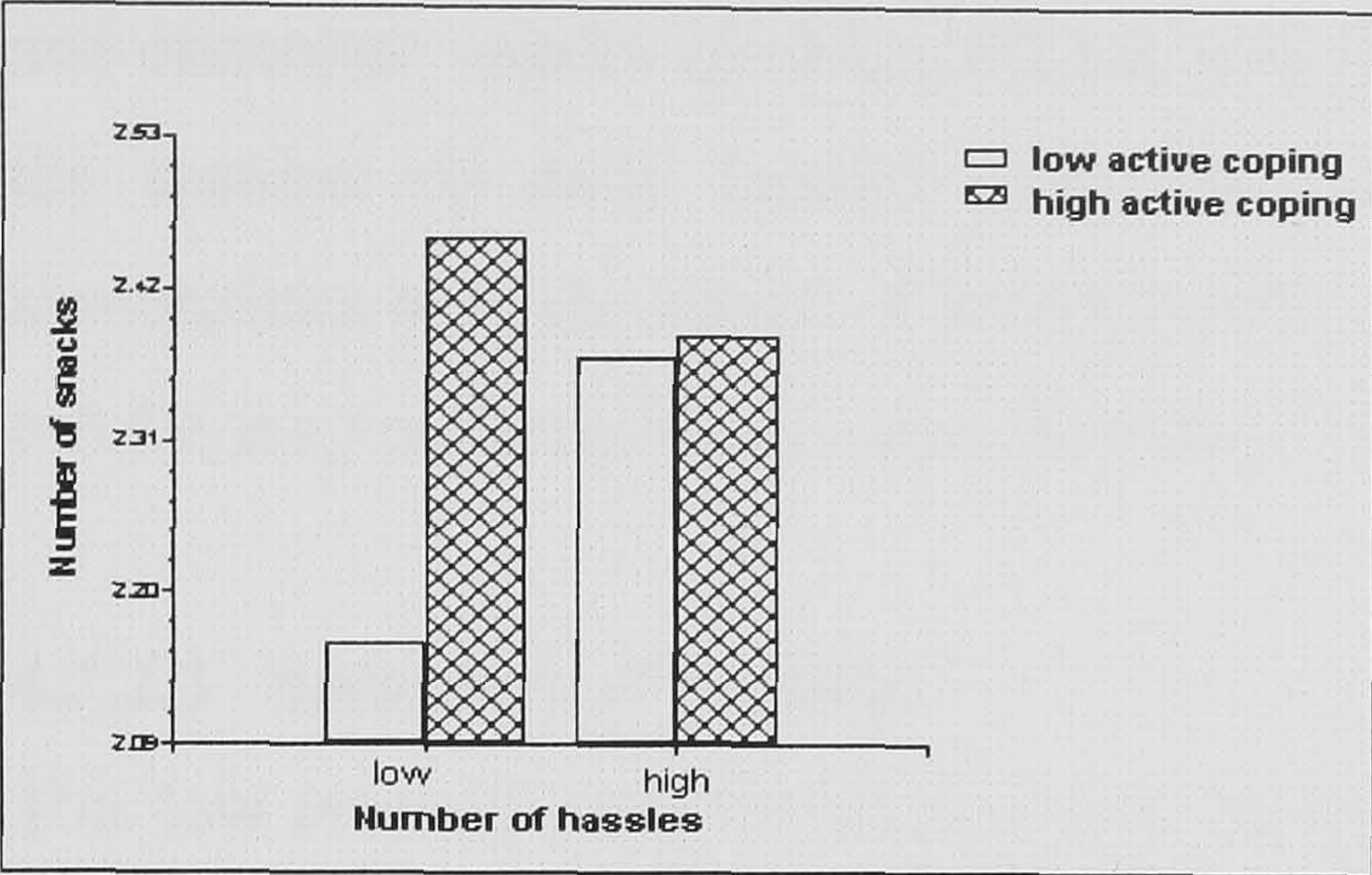
increased with a greater number of hassles. The number of hassles did not significantly interact with external eating, restraint or disinhibition (all  $p > 0.05$ ); but did interact with rigid control ( $\beta = -0.06$ ,  $t = -2.11$ ,  $p < 0.05$ ), flexible control ( $\beta = -0.08$ ,  $t = -2.08$ ,  $p < 0.05$ ) and emotional eating ( $\beta = -0.02$ ,  $t = -2.63$ ,  $p < 0.05$ ). In all cases, the association between the number of hassles and snack intake weakened with increasing scores on the eating style variable. There was also a significant positive association between the intensity of hassles experienced and snack intake in the high reactor group ( $\beta = 0.51$ ,  $t = 6.30$ ,  $p < 0.001$ ), such that a greater number of snacks was consumed with higher hassle intensities. Emotional eating and flexible control showed no significant interactions with the intensity of hassles (both  $p > 0.05$ ). Hassle intensity showed significant negative cross-level interactions with external eating ( $\beta = -0.03$ ,  $t = -2.19$ ,  $p < 0.05$ ) and disinhibition ( $\beta = -0.05$ ,  $t = -2.44$ ,  $p < 0.05$ ), so that the relationship between hassle intensity and snack intake weakened as scores on external eating and disinhibition increased. There were significant positive cross-level interactions between the intensity of hassles and restraint ( $\beta = 0.04$ ,  $t = 5.42$ ,  $p < 0.01$ ) and between hassle intensity and rigid control ( $\beta = 0.07$ ,  $t = 3.22$ ,  $p < 0.01$ ), indicating that the relationship between hassle intensity and intake was strengthened as both the restraint scores increased.

Coping style also appeared to moderate the relationship between the number of daily hassles and snack intake in high reactors. The number of hassles interacted with active coping ( $\beta = -0.05$ ,  $t = -4.25$ ,  $p < 0.001$ ), and emotional coping ( $\beta = -0.05$ ,  $t = -2.72$ ,  $p < 0.05$ ) in predicting overall snack intake, but there was no interaction between hassle number and avoidance coping score ( $\beta = -0.03$ ,  $t = -1.38$ , n.s.). The coefficients showed that there was a stronger association between the number of hassles and snack intake when emotional coping scores were lower, suggesting a protective effect of this coping strategy on intake. Figure 4.2 shows the relationship between the number of hassles and snack intake with high and low active and emotional coping.

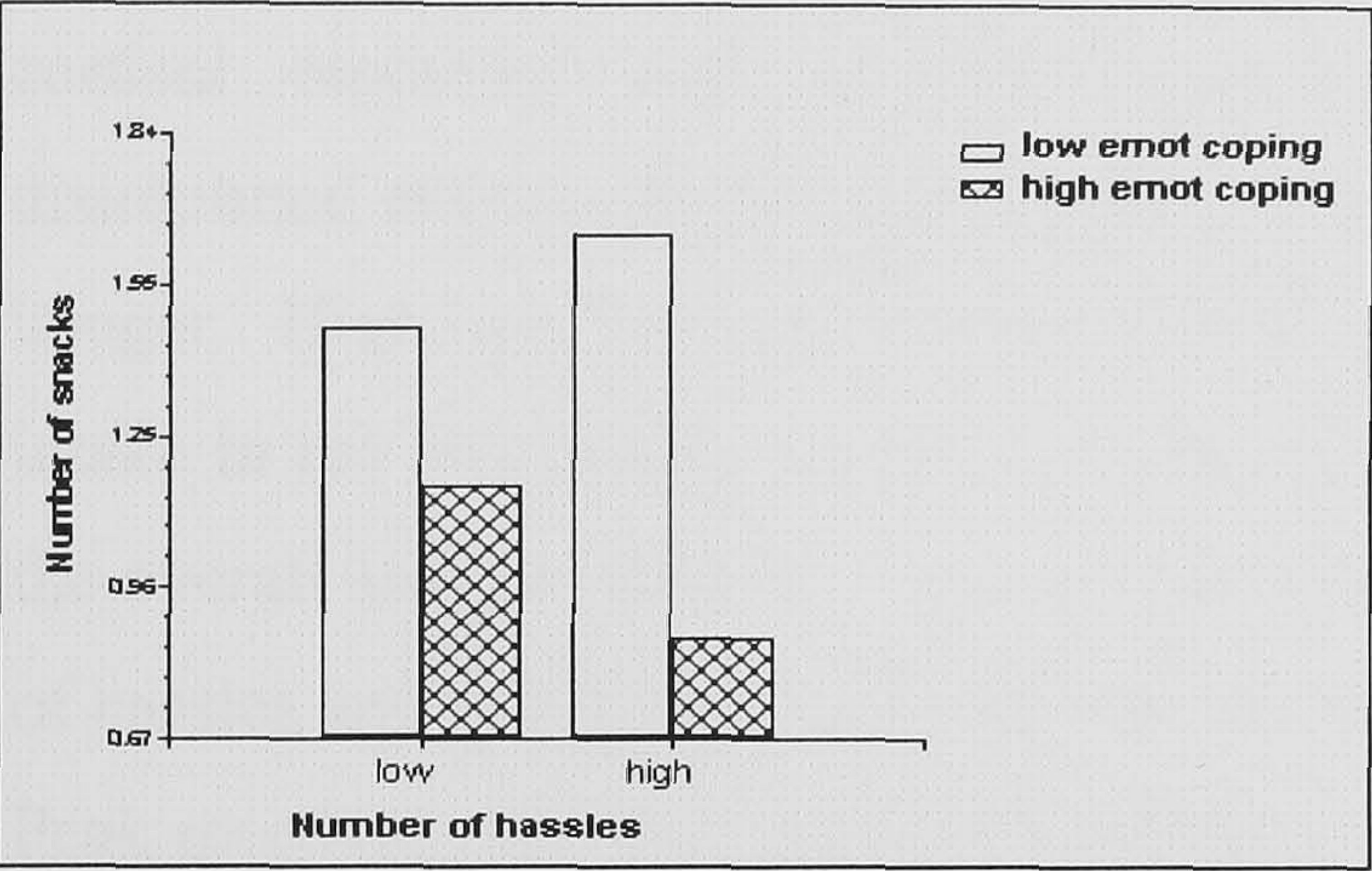
Figure 4.2a shows that the high active copers reduced their snack consumption as the number of hassles increased, while low active copers increased their snack intake. Figure 4.2b shows a similar pattern with emotional coping, so that high



emotional copers decrease snack intake, and low emotional copers increase snack intake, as the number of hassles increases.



a.



b.

**Figure 4.2 Relationship between the number of hassles and snack intake in a. high and low active copers, and b. high and low emotional copers**

The positive association between hassles and intake in the high reactors remained significant for the presence of the different hassle types. The presence of ego-threatening hassles was associated with increased snack consumption ( $\beta=0.51$ ,  $t=4.32$ ,  $p<0.001$ ), as was the presence of interpersonal hassles ( $\beta=0.35$ ,  $t=3.68$ ,  $p<0.01$ ), work-related hassles ( $\beta=0.35$ ,  $t=3.72$ ,  $p<0.01$ ) and household chore hassles ( $\beta=0.49$ ,  $t=5.22$ ,  $p<0.001$ ).

In the low reactors, the number of hassles was not significantly associated with the intake of fruit ( $\beta=0.04$ ,  $t=0.77$ , n.s.), was negatively associated with the intake of crisps and nuts ( $\beta=-0.05$ ,  $t=-2.44$ ,  $p<0.05$ ) and biscuit and cake snacks ( $\beta=-0.17$ ,  $t=-4.14$ ,  $p<0.001$ ), and positively associated with intake of sweets and chocolate ( $\beta=0.21$ ,  $t=4.89$ ,  $p<0.001$ ). The coefficients indicated that the intake of sweets and



chocolate increased, but intake of crisps and nuts and biscuits and cakes decreased with daily hassles, in low cortisol reactors. In the high reactors, there was also a significant association between the number of daily hassles and the intake of sweets and chocolate snacks ( $\beta=0.12$ ,  $t=2.82$ ,  $p<0.05$ ), indicating that intake increased as the number of daily hassles increased. However, there were no significant associations with the intake of fruit ( $\beta=-0.04$ ,  $t=-0.80$ , n.s.), crisps and nuts ( $\beta=0.02$ ,  $t=0.89$ , n.s.) or biscuits and cakes ( $\beta=0.02$ ,  $t=1.16$ , n.s.).

#### **4.2.2.3 Summary of findings**

The low cortisol reactors scored more highly on extraversion than high reactors. Eating style scores did not significantly differ between the two groups, but peak cortisol reactivity was positively associated with emotional, external and disinhibited eating. Snack intake in the laboratory was only predicted by BMI and hunger. High and low cortisol reactors did not differ significantly in overall snack intake in the laboratory, nor in the intake of sweet or high fat snacks. In the field, the overall sample showed a positive relationship between the number and intensity of hassles and snack intake, particularly the intake of fruit and sweets and chocolate. Peak reactivity was also positively related to increased snack intake. High cortisol reactors showed a positive relationship between the number of daily hassles and snack intake, particularly intake of sweets and chocolate, and in response to ego-threatening, interpersonal and work-related hassles. The positive association between hassle intensity and intake in the high reactors was strengthened by increasing restraint and rigid restraint. Coping style also moderated the relationship between the number of hassles and snack intake, so that increasing scores on emotional and active coping weakened the association. However, the number of hassles was unrelated to snack intake in low reactors.

#### **4.2.3 Discussion**

The aims of Study Six were to test the association between cortisol reactivity to stress and snack intake, in both a laboratory and field setting. The study further aimed to test whether cortisol reactivity would predict the intake of different types of snack, and whether eating style moderators of stress-induced eating would show an association with cortisol production.

### ***Stress reactivity, anxiety and personality***

The high and low reactors differed in state anxiety, with the high reactors scoring more highly than low reactors, although stress ratings were not significantly different between the two groups. This fits with previous reports that high anxiety and negative affect are associated with increased stress reactivity (Habra et al., 2003; Roberts et al., 2004; Smyth et al., 1998). The high and low reactors also differed in extraversion level, with greater levels of extraversion found in the low reactors. Previous studies have shown that introverts are generally more aroused than extraverts (Blumenthal, 2004), but the current finding also suggests that introverts may be more reactive to stressful stimuli, as baseline cortisol values were taken into consideration in the current study. This may relate to the nature of the stressor used in this particular study, since it involved presentation and performance, which might be expected to cause greater anxiety in introverts. It would therefore be interesting to investigate whether extraverts and introverts show differences in cortisol reactivity for stressors that are not performance-based.

The high and low cortisol reactors did not differ in any of the other personality measures including emotional stability and hostility. This latter finding is contrary to previous reports that individuals high in hostility are more reactive to stress, in terms of neuroendocrine and cardiovascular reactivity (e.g. Suarez et al., 1998). Again, this difference may reflect the type of stressor employed in the current study, since interpersonal and anger-inducing stressors may be more likely to highlight differences in reactivity between high and low hostile individuals (Suls & Wan, 1994).

### ***Stress reactivity and eating style***

High and low cortisol reactors did not differ along any of the eating style measures in the current study, including restraint, emotional and external eating. However, there were significant positive correlations between peak cortisol reactivity and emotional eating, external eating, disinhibition and rigid control restraint, showing that reactivity increased with each of these eating style variables. Previous studies have shown that highly restrained individuals produce greater levels of cortisol than non-restrained individuals (e.g. Anderson et al., 2002). However, the findings from the current study support greater cortisol reactivity to stress in individuals



susceptible to stress-induced eating, which could cause speculation that greater reactivity to stress relates to subsequent eating behaviour in these individuals.

### ***Stress reactivity and snack intake in the laboratory***

Within the laboratory, there were no significant differences in the number of kilocalories consumed by high and low reactors, except in the intake of the low fat, sweet food, where low reactors consumed a greater amount. As an overall sample, the greatest number of calories was consumed from the high fat foods available, though this may be due to the palatability of the high fat foods, since these were also most liked by the sample. The high and low reactors did not differ in the amount of high or low fat, or sweet and savoury snacks, nor in the proportions of these snacks in their overall intake. These findings stand in contrast to those of Epel et al. (2001), who reported greater intake in high reactors, especially of sweet foods. It is unclear why the findings should differ between the two studies. However, a much longer stress procedure was employed in the Epel et al. study, with cortisol measurements taken over a longer period of time. It is possible that these two factors contributed to the differences in findings through the different time period for cortisol output.

### ***Stress and intake in the field***

Hierarchical multivariate linear modelling of the relationship between daily hassles and snack intake revealed that a greater number of snacks were consumed when a greater number and intensity of hassles was reported, in the overall sample. In particular, the intake of fruit snacks and sweets and chocolate was increased when more hassles were experienced. Further investigation of the type of hassles associated with snack intake revealed that the presence of ego-threatening, interpersonal and work-related hassles was associated with increased snack intake. In contrast, time-related, household chore and physical hassles were unrelated to snack intake. This corresponds with previous reports of increased intake in response to these stressor types (Heatherton et al., 1991; Oliver et al., 2001; Tanofsky-Kraff et al., 2000; Wardle et al., 2000). The findings are also consistent with those of O'Connor et al. (2005), who reported that ego-threatening, interpersonal and work hassles were associated with increased intake, also in a hierarchical multivariate linear modelling analysis of stress and eating in the field.

Separate hierarchical linear modelling with the high and low cortisol reactors revealed that there was no association between the number and intensity of hassles with snack intake in low reactors. However, the high reactors showed a positive association between the number of hassles encountered and snack intake. In particular, the presence of ego-threatening, interpersonal and work-related hassles was associated with increased snack consumption in high reactors. There was also an increased intake of sweets and chocolates with increased daily hassles in high reactors. This corresponds with Epel et al.'s (2001) report that high cortisol reactors consumed a greater amount of sweet foods than low reactors in the laboratory. While the laboratory findings in the present study did not replicate this finding, the field results are still consistent with the hypothesis that the intake of sweet foods would particularly increase in high cortisol reactors. The current study therefore supports the conjecture that high cortisol reactivity to stress does not only increase food intake, but is associated with increased consumption of sweet foods in particular. This is consistent with the notion that increased intake during stress may have once served an evolutionary purpose (e.g. Sapolsky, 1998), especially the intake of sweet, carbohydrate-rich foods which would help to replenish energy levels following a stressful encounter. As yet it is unknown how cortisol production could affect appetite for sweet foods; however, a greater understanding of this mechanism would provide insight into the link between cortisol reactivity and intake of sweet snacks.

### ***Moderating role of eating style***

In the overall sample, restraint, emotional eating, external eating and disinhibition were positively related to snack intake in the field. Only emotional eating style remained significant when all variables were entered simultaneously, suggesting that emotional eating was the strongest predictor of increased snack intake. However, none of the eating style variables interacted with the number or intensity of hassles to predict snack intake, suggesting that eating style did not moderate the relationship between stress and eating within the whole sample. This result contrasts with the findings of O'Connor et al. (2005), who reported that emotional eating moderated the relationship between daily hassles and snack intake, where the hassles-snack intake relationship was stronger as emotional eating increased. However, the present study reported that dietary restraint and rigid control restraint showed



positive cross level interactions with hassle intensity to affect snack intake in high cortisol reactors, so that the relationship was strengthened by increasing restraint scores. Therefore, there was supportive evidence from the field that dietary restraint increases the tendency to eat in response to daily stress in high reactors.

### ***Moderating role of coping style***

The relationship between daily hassles and intake in the high reactor group appeared to be moderated by coping style. The relationship between daily hassles and intake was stronger in those individuals with lower scores on both active and emotional coping, and much weaker in those with high active and emotional coping scores. However, avoidance coping, such as pretending that the stressor does not exist, did not affect the relationship. It was suggested that active and emotional coping could lessen the association between hassles and behavioural responses such as increased intake, whereas avoidance coping could increase this relationship. While the hassles-snack intake association was not strengthened by increasing avoidance coping, this form of coping did not serve to lessen the relationship. Previous researchers have also shown that avoidance coping is less effective than active and emotional strategies and can add to distress (e.g. Lyne & Roger, 2000; O'Connor & O'Connor, 2003). The findings presented here further suggest that high reliance on emotional coping strategies in particular serves to reduce the effects of stress on eating behaviour, and possibly other behaviours unrelated to the source of distress, whereas avoidance coping did not offer this effect.

### ***Strengths and limitations***

The relationship between cortisol reactivity and snack intake has previously been investigated in the laboratory, as has the relationship between the extraneous administration of glucocorticoids and ad libitum intake. However, no studies have followed the relationship between cortisol reactivity to stress and intake in a natural setting. Therefore, one particular strength of the current study was that the intake of high and low cortisol reactors was further measured in the field as well as in the laboratory. Hierarchical linear modelling has only once been previously employed to test the relationship between daily stress and intake by other researchers, though this tool allows much greater insight into the relationship between daily events

within individuals. Therefore, a second strength of the study was the use of this statistical method to test the relationship between hassles and intake.

A limitation of the current study was the limited food choice in the laboratory component. It is possible that this factor contributed to the lack of relationship between cortisol reactivity and snack intake in the laboratory. A further limitation was the use of an adapted Trier Social Stress Test so that the procedure could be conducted by one experimenter, with no confederates. The use of this adapted version of the stress test may explain why many of the participants showed little reactivity, since their speech and arithmetic performance was for an audience of only one person, whom they had already met, rather than an audience of three strangers. The average cortisol increase was lower than previous studies have reported with the full TSST (e.g. Kirschbaum et al., 1992), which suggests that the procedure may be less stressful. However, the participants in the present study did report the procedure to be stressful, and anxiety scores were significantly increased from baseline. It is therefore unlikely that the membership to high and low reactivity groups was affected by the stressfulness of the task.

### ***Conclusions***

The current study found no significant difference in snack intake between high and low cortisol reactors in the laboratory. In a naturalistic setting, high reactors, but not low reactors, showed an association between daily hassles and snack intake, where a greater number of hassles was associated with increased snack intake. This increased intake was found for sweets and chocolate snacks in particular, and in response to ego-threatening, interpersonal and work-related hassles. High scores on active and emotional coping did, however, reduce the relationship between hassles and intake. Increasing scores of restraint and rigid restraint strengthened the relationship between hassle intensity and snack intake in high cortisol reactors. The results of the current study support a role of cortisol reactivity in the relationship between stress and food intake, where greater reactivity promotes increased food consumption.



## CHAPTER FIVE

### MODERATORS AND MECHANISMS UNDERLYING STRESS-INDUCED EATING: GENERAL DISCUSSION OF STUDIES ONE TO SIX

#### 5.1 Aims of the thesis restated

The thesis investigated both the moderators and mechanisms of stress-induced eating with the aim of addressing three main questions: Who is susceptible to changes in food intake during stress? Under what circumstances are changes in intake expected? What mechanisms account for changes in intake with stress? In particular, increased food intake during stress, rather than decreased intake, was the focus of investigation, since increased obesity and poor diet are currently of important social and political concern (e.g. UK DoH Summary of Intelligence on Obesity, 2004; BBC Health News, 16<sup>th</sup> November, 2004). The thesis aimed to examine the relationships between the moderators of stress-induced intake, by testing the relationship between daily stress and intake over one day (Study One) and over a period of two weeks (Studies Two and Six). The second aim of the thesis was to test the roles of stressor characteristics and food type in predicting intake response to stress (Studies One and Six), to test the circumstances under which increased intake occurs. The thesis also tested two possible mechanisms for stress-induced eating, with the aim of accounting for intake changes. A cognitive attentional bias mechanism was first investigated (Studies Three, Four and Five), followed by a neuroendocrine reactivity mechanism (Study Six).

#### 5.2 Who is susceptible to stress-induced eating?

##### 5.2.1 General effects and individual differences approaches to stress-induced eating

Greeno and Wing (1994) proposed a distinction between studies adopting a general effects and individual differences approach to the study of stress-induced eating. Whereas the general effects approach views stress-related intake as uniform across individuals, the individual differences approach attempts to uncover the characteristics that would predict the direction of intake response. The studies presented in the thesis supported the individual differences approach. Study One

revealed that individuals differed in their perceived response to stress, in terms of both snack and overall food intake. While the greatest proportion of the student sample reported eating more during stress, many others also reported eating the same amount or less. This finding corresponds well with the previous studies of Oliver and Wardle (1999) and Willenbring et al. (1986), who also reported variations in perceived effects of stress on food intake.

Studies Two and Six in the thesis found positive associations between daily hassles and snack intake, showing that food intake increased as stress increased within the overall sample. However, further analysis revealed that these positive associations were stronger within certain subgroups. Overall, individuals' differential perceptions of stress-induced intake in Study One and stronger associations between stress and intake in Studies Two and Six suggest that an individual differences approach to the study of stress-induced eating is more appropriate than the general effects approach, as Greeno and Wing (1994) purported.

### **5.2.2 Bodyweight and gender as moderators of stress-induced eating**

Early research suggested that bodyweight moderated the relationship between stress and eating. Obese individuals were found to be more prone to stress-induced eating than normal weight individuals (e.g. McKenna, 1972; Pine, 1985), or to not reduce food intake in response to stress as normal weight individuals did (Schachter et al., 1968). However, body mass index did not emerge as a moderating factor within the studies presented in this thesis. One possible reason for this discrepancy is that the participants in previous research were relatively more overweight than those considered overweight in the present studies, which may have allowed differences between obese and normal weight individuals to emerge in previous studies. Since overweight individuals were not pre-selected in the studies reported here, there was little variation in BMI to enable an effect of bodyweight to emerge. It is also possible that other moderators of stress-induced eating account for the differences in eating behaviour between overweight and normal weight persons. Overweight and normal weight individuals have previously been shown to differ in levels of emotional eating (Lowe & Fisher, 1983), external eating (Schachter et al., 1968) and restraint (Polivy et al., 1978; Ruderman & Wilson, 1979), and Study One reported a positive association between disinhibition and BMI. Therefore, the previous role



found for bodyweight may be attributable to its associations with eating style moderators of stress-induced eating, and its effect might only emerge with a group of highly obese individuals.

The studies presented here provided some support for a moderating role of gender. In Study One, female respondents were more likely to report a hyperphagic response to stress for both overall and snack intake than were males. This finding is consistent with previous laboratory research showing a greater tendency towards increased intake in stressed females than in stressed males (Grunberg & Straub, 1992), although other laboratory and field studies have found no gender differences in eating response to stress (Conner et al., 1999; Pine, 1985). It was not possible to test the moderating effect of gender in Studies Two or Six, due to a small male sample in Study Two and the all-female sample in Study Six. However, the data from Study One do suggest that in terms of self-perceptions, a hyperphagic response to stress is more prevalent in females than in males.

### **5.2.3 Eating style moderators of stress-induced eating**

Dietary restraint has been the most commonly tested moderator of stress-induced eating in previous research. Studies have shown that restrained eaters, but not unrestrained eaters, disinhibit food intake in response to laboratory stressors (Herman & Polivy, 1975; Schotte et al., 1990) and stressors encountered in everyday life (Wardle et al., 2000). In particular, rigid restraint, rather than flexible restraint, has been most associated with disinhibition (Westenhoefer et al., 1994; Westenhoefer et al., 1999). The studies presented in this thesis did support a moderating role of dietary restraint to an extent, but findings were somewhat inconsistent. Study One found no effect of restraint on the relationship between stress ratings and snack intake over one day. Similarly, Study Six reported no moderating effect of restraint on the hassles-snack intake relationship over a two-week period in the whole sample; though did report that restraint, and rigid restraint in particular, moderated the relationship between hassle intensity and snack intake in high cortisol reactors. Study Two found that flexible restraint moderated the relationship between daily hassles and intake over two weeks, such that highly restrained individuals increased their snack intake when a greater number of hassles was experienced, as is consistent with previous research. Furthermore, the results

from Study Two showed that both rigid and flexible restraint moderated the relationship between the intensity of work-related hassles and snack consumption, whereby highly restrained individuals increased snack consumption with increased work hassle intensities.

Therefore, the findings from one study presented here supported the expected association between dietary restraint and stress-induced intake, and the findings from one study showed the expected moderating effect in high cortisol reactors alone. It is unclear why Study One did not find any moderating effect of restraint. The use of the Dutch Eating Behaviour Questionnaire to measure restraint and the daily record of snack intake may have contributed to the null findings in Studies One. It has previously been observed that the moderating role of dietary restraint is more prevalent when the Restraint Scale (Herman & Polivy, 1980) is employed, a finding that is attributed to the DEBQ measuring successful dietary restraint, and the Restraint Scale measuring unsuccessful restraint (Ricciardelli & Williams, 1997). However, this scale was also employed in Study Two, where a moderating role of restraint was found, so it is unlikely that the use of the DEBQ scale can completely account for the lack of moderation effect. Studies Two and Six measured snack intake over a period of fourteen days, whereas Study One only measured hassles and intake across one day. Since daily snack intake may be affected by a number of factors additional to stress, including snack availability, social and time factors, this snapshot approach to measuring the relationship between daily hassles and snack intake may not be ideal for testing the moderating role of eating style, and could have contributed towards the lack of moderation effect of restraint in Study One.

It is also possible that the moderating role of dietary restraint is more likely to occur in the laboratory, whereas Studies One, Two and Six studied eating behaviour in the field. Other naturalistic studies have also failed to find a moderating role of restraint (e.g. O'Connor & O'Connor, 2004; Pollard et al., 1995), which suggests that the effect could be more common to the laboratory. This does not explain why Study Six found no effect of restraint on the amount eaten in response to a laboratory stressor. However, Study Six offered a variety of test foods, and it has also been argued that the restraint effect is more likely when a single test food, usually ice cream, is offered, rather than a range of test foods (Shapiro & Anderson, 2005).



Although Study Two reported that daily hassles and snack intake were more positively associated in highly restrained individuals, as previous findings would predict, there may be factors specific to laboratory studies that make the moderating role of dietary restraint more elusive in the field.

Emotional eating emerged as the strongest eating style moderator of stress-induced eating in the studies reported in this thesis, though there was some inconsistency between the studies. Study One reported that emotional eating was a significant predictor of a perceived hyperphagic response to stress. In female, high emotional eaters specifically, there was a positive relationship between stress and intake of sweets and chocolate snacks. Therefore, the results of Study One supported previous findings that stress induces increased intake in high rather than low emotional eaters (e.g. Oliver et al., 2000; Van Strien et al., 2000). However, Study Six did not find a moderating effect of emotional eating on the relationship between stress and eating in the laboratory or field, as is also consistent with other studies (e.g. Conner et al., 1999). Study Two reported that high emotional eaters consumed fewer snacks with greater overall hassle intensities; yet high emotional eaters showed an increase in snack consumption with a greater intensity of physical hassles specifically. Therefore the moderating role of emotional eating may be dependent on the characteristics of the stressor, particularly since reported hassles were self-coded by the participants in participants in Study Two. Taken together, a moderating role of emotional eating was supported, though whether it serves as a moderator or not may be dependent on the type of stressor experienced.

External eating was an inconsistent moderator of stress-induced eating across Studies One, Two and Six. Studies One and Six found no evidence of a moderating role for external eating style. These null effects contrast with the findings of Conner et al. (1999), who reported increased snack consumption in external eaters in response to daily hassles. Since the Conner et al. study employed a diary methodology, it is possible that the cross-sectional design of Study One masked any effects of external eating; however, this does not explain why external eating did not emerge as a predictor in the analysis of diaries from Study Six. The results from Study Two showed that high external eaters consumed more snacks when fewer hassles were experienced. However, when health and body-related hassles were

analysed specifically, high external eaters consumed a greater number of snacks when greater hassle intensities were experienced. This is very similar to the moderating role of emotional eating that emerged from Study Two and again suggests that the characteristics of the stressor may affect the moderating role of external eating.

Disinhibition showed a similar pattern of results across the studies to external eating style. While Studies One and Six failed to find a moderating effect of disinhibition score, Study Two reported that high disinhibitors reported a greater number of snacks as the intensity of health and body-related hassles increased. These differences are difficult to explain, since previous reports have found disinhibition to be a strong moderator, whereby high disinhibitors increase snack consumption when stressed (Ouwens et al., 2003; Van Strien et al., 2000). This effect was only observed for physical hassles in Study Two, and not at all in Studies One and Six. Overall, Studies One, Two and Six found evidence of a moderating role of emotional eating in the stress-eating relationship and some support for the role of dietary restraint, but did not very well support external eating or disinhibition as moderators. However, the moderating effects of disinhibition, external and emotional eating were more prevalent with physical hassles, suggesting that the moderation effect of eating style differs according to stressor type. Therefore it would be valuable for future research to examine in more detail the cognitive, emotional and physical responses to different stressors, to determine which stressor characteristics predict increased intake in eating style subgroups.

#### **5.2.4 Personality moderators of stress-induced eating**

The personality variables did not by themselves appear to moderate the stress-eating relationship. However, the personality variables did show associations with other variables. Since emotional reactivity to stress has been found to be greater in those susceptible to increased food intake under stress (e.g. Abramson & Wunderlich, 1972) it may be expected that neuroticism, or a lack of emotional stability, would be similarly associated with increased intake because those low in emotional stability would react more strongly to stress. No moderating role of emotional stability was found in any of the studies reported here, but both Studies One and Two reported that emotional stability was negatively associated with emotional eating,



disinhibition and restraint. It is therefore possible that low emotional stability contributes to the development of emotional, restrained and disinhibited eating styles, which are then associated with increased susceptibility to stress-induced eating. Interestingly, extraversion was associated with neuroendocrine reactivity in Study Six, such that high extraversion scorers reacted less strongly to the stressor. This may reflect the nature of the stressor used in Study Six, since it involved performance of a public speech, which would be expected to affect extraverts to a lesser extent than introverts, although other studies have shown evidence of greater arousal and arousability in introverts (Dabbs & Hopper, 1991; Blumenthal, 2001). Therefore it would be useful for future research to test whether extraverts and introverts differ in response to other stressors.

Conscientiousness and perfectionism both showed interesting associations with restraint in Study Two. While conscientiousness was positively associated with DEBQ restraint and flexible control, perfectionism was positively related to DEBQ restraint and rigid control restraint. Since rigid control is more greatly associated with disinhibited intake than flexible control (Westenhoefer et al, 1999), it appears that perfectionists tended to possess the all-or-nothing approach to dieting and subsequent disinhibited eating, while high conscientiousness individuals adopted a more realistic approach to diet, which was less susceptible to increased intake. This fits with previous research, which has shown a positive association between perfectionism and pathological eating (e.g. Cockell et al., 2002; Franco-Paredes et al., 2005). In contrast, high conscientiousness has tended to be greater in individuals not susceptible to disordered or disinhibited eating (Heaven et al., 2001; O'Connor & O'Connor, 2004). While conscientiousness and perfectionism did not of themselves moderate stress-induced eating, the findings reported in Study Two suggest that they are associated with normal and disinhibited eating respectively, and may predispose individuals to certain eating styles. However, more studies are required to test these interesting associations between personality and rigid and flexible restraint further, and to test whether conscientiousness and perfectionism are precursors of these types of restraint.

### **5.3 What situational circumstances affect the relationship between stress and eating?**

#### **5.3.1 The effect of stressor type on stress-induced eating**

Studies One, Two and Six investigated the effect of stressor type on intake, focusing on physical, ego-threatening, work-related, time-related, interpersonal and chore stressors. Although it has been suggested that certain types of stress are more greatly associated with intake than others, few studies have investigated the effect of different stressor types (e.g. Heatherton et al., 1991), and even fewer have conducted such investigations in the field (e.g. O'Connor et al., 2005). Therefore, to investigate how different stressor types were associated with intake was one of the main aims of the thesis. In Studies One, Two and Six, interesting relationships between physical, ego-threatening, work-related and interpersonal stressors and snack intake emerged. The effect of physical hassles on intake was not straightforward, and appeared to depend on other moderators. Study One reported that physical hassles were associated with decreased consumption. Similarly, previous reports have also found a negative relationship between physical stress and intake (Heatherton et al., 1991; O'Connor et al., 2005).

However, there was a positive association between the occurrence of physical hassles and fruit intake in females in Study One, and a positive relationship between the intensity of physical hassles and the number of snacks consumed in Study Two, particularly in external, emotional and disinhibited eaters. While this conflicts with Heatherton et al. (1991), the positive findings may reflect the difference in operationalisation of physical stressors between the previous study and those reported in this thesis. While Heatherton et al.'s stressor involved the threat of electric shocks, the physical hassles here involved a wide range of stressors, including exercise and illness. It was suggested that the intake of fruit in female students in Study One could reflect a generally healthy lifestyle, involving exercise and eating healthily. It is also possible that increased intake in individuals susceptible to stress-induced eating in Study Two's employed sample was due to absenteeism with illness, and a greater exposure to snacks at home. Therefore, the sampling population could affect the relationship between physical hassles and snack intake. As previously suggested, it would be particularly helpful for future



research to examine in closer detail the characteristics of physical hassles that predict either increased or decreased intake in the different eating style subgroups, to elucidate these findings.

Study Six reported that ego threatening, interpersonal and work-related hassles were associated with increased intake. These associations correspond well with previous theory and findings surrounding the type of stress affecting food intake. Heatherton et al. (1991) argued that an ego threat is a necessary component of stress to induce eating, as it prompts individuals to decrease their awareness of the self and allows normal inhibitions to be much reduced. This proposed relationship between ego threatening stress and intake was supported in Study Six. However, it appears that interpersonal and work-related hassles are also capable of inducing food intake. Although these hassle types do not involve a direct ego threat, the associations between interpersonal and work-related hassles with increased intake are still consistent with previous research findings (O'Connor et al., 2005; Oliver et al., 2001; Wardle et al., 2001). Therefore, the studies presented showed evidence of increased intake in response to ego-threatening, interpersonal and work-related hassles. Physical hassles were associated with decreased snack intake in one study, but with increased intake in susceptible individuals in another study. However, further exploration of cognitive, emotional and physical responses to different stressor characteristics in future studies should help to clarify these findings.

### **5.3.2 Food choice during stress**

Studies One and Six tested whether the effect of stress on intake differed with different food types. The diary component to Study Six reported that the number of hassles experienced was positively associated with the intake of sweets and chocolates and fruit snacks. The increase in these snack types suggests a tendency towards increased consumption of sweet foods during stress, as previous studies have also reported, especially in women (Grunberg & Straub, 1992; Oliver et al., 2000). Study One reported a significant association between stress ratings and the intake of crisps and nuts, rather than sweets, chocolates and fruit, especially among the female respondents. Despite the contrast with Study Six, these results are still consistent with previous research. A preference for crisps during stress has previously been reported (Shapiro & Anderson, 2005), as has a preference for

crunchy foods (Willenbring et al., 1986), a category into which both crisps and nuts would fit.

Interestingly, previous research has shown that stress-eaters themselves have professed preferences for both salty and sweet foods (Laitinen et al., 2002), which could account for the changes in fruit, sweets and chocolate and crisps and nuts intake reported in Studies One and Six. Alternatively, Shapiro and Anderson (2005) propose that individuals crave energy rich foods when stressed, which would also account for the findings from the two studies. This craving for energy rich foods when stressed also fits with the evolutionary argument that eating when stressed serves to replenish lost energy from the fight or flight response (Sapolsky, 1998). Therefore, the findings from Studies One and Six suggest that stress is related to increased intake of crisps and nuts, sweets and chocolates and fruit. Furthermore, these findings may represent a desire to eat energy rich foods to restore energy levels following a stressful encounter, which once served a survival function. While this may result in an increase in the intake of unhealthy foods, the observed increase in fruit intake highlights that this is not necessarily the case.

#### **5.4 What underlying mechanisms account for stress-induced eating?**

##### **5.4.1 Attentional bias mechanism underlying stress-induced eating**

Studies Three, Four and Five addressed whether an attentional bias mechanism could account for stress-induced eating, particularly in external eaters. These three studies did not measure actual eating behaviour in response, and instead concentrated on cognitive factors during stress as a possible mechanism for stress-induced eating. Heatherton and Baumeister (1991) proposed that individuals ‘escape’ their stressor by reducing self-awareness, shifting their attention away from the source of stress and towards the immediate environment. Taking this theory a step further, it was proposed that certain individuals shift their attention specifically towards food stimuli when stressed, which would explain increased intake in external eaters who eat in response to the presence of food. An attentional shift could also explain increased intake in restrained eaters, since a focus on the immediate environment is theorised to reduce awareness of usual inhibitions and the consequences of disinhibition (Heatherton & Baumeister, 1991). Although previous



studies have investigated attentional bias for food stimuli in restrained eaters, none have tested the interaction between stress and restraint, or stress and external eating for biases towards food stimuli.

The modified Stroop task in Study Three reported that high external eaters showed positive biases for snack words when stressed, but not in a control condition. In contrast, the low external eaters showed a greater bias for snack words in the control condition. This pattern was not observable for all food types and therefore limited to snack food words. Study Four reported that high external eaters showed a greater bias for unhealthy food words presented at the longest exposure time of 1000ms when in the stress condition, while low external eaters had a negative bias for these words. However, this effect was not observed for subliminal presentation of words, suggesting that the bias was conscious rather than preconscious. Taken together, the Stroop findings from Study Three and the dot probe results from Study Four provide support for the theory that external eaters show attentional biases for particular types of food, i.e. snack or unhealthy foods, when stressed, but not all food stimuli.

The findings of Study Five did not lend further support for an attentional orienting towards food stimuli in external eaters, when measuring attentional biases for food pictures. In contrast, stressed external eaters showed an avoidance of food pictures when stressed. Since food pictures would be expected to be much more salient cues than food words, it is difficult to explain the findings, though the study was exploratory with a small sample size, which made tests of three-way interactions weak. However, the avoidance of food stimuli in external eaters was somewhat consistent with the results from Study Three, except in the case of snack foods in Study Three. This avoidance is also consistent with the previous report of avoidance of food words in external eaters (Johansson et al., 2004). One possible explanation for this pattern of results is that high external eaters try to avoid food stimuli under normal conditions to prevent overeating, but that this avoidance cannot be maintained for all food stimuli when stressed. Though some inconsistencies emerged between the three studies, in all three studies there was no evidence that high and low external eaters responded differently to the stressor, and so this cannot account for the differences in findings. Together the findings from the three studies provide some support for an attentional bias mechanism of stress-induced eating in

external eaters, where high external eaters shift attention towards snack and unhealthy food stimuli when stressed, but avoid food stimuli under normal, non-stressed conditions.

The results from Study Three did not provide support for the attentional bias mechanism in restrained eaters. In contrast, the highly restrained eaters showed smaller bias scores than low restrained eaters for food stimuli. Previous research has also been inconsistent in showing a difference in biases for food stimuli between restrained and unrestrained eaters (e.g. Francis et al., 1997; Jansen et al., 1998; Lattimore et al., 2000). However, it is possible that cognitive load accounts for previous interference effects and increased intake in restrained eaters (Ward & Mann, 2000). While distracted, or completing a task that requires attention, restrained eaters may be distracted from their usual dietary intake restrictions (Boon et al., 2002). This theory would fit with the findings from Study Two, where highly restrained individuals consumed a greater number of snacks when the number of work-related hassles increased. This suggests that increased cognitive demand of work tasks could induce increased intake in restrained eaters. This theory therefore warrants further investigation in the field. Overall, the evidence for an attentional bias mechanism for stress-induced eating in restrained eaters was less convincing than for external eaters.

#### **5.4.2 Cortisol reactivity mechanism underlying stress-induced eating**

Study Six tested the possibility of a cortisol mechanism for stress-induced eating. While this possibility has previously been tested in the laboratory (Epel et al., 2001), no previous studies have tested the relationship between cortisol reactivity and eating response to stress in the field. The results from Study Six showed that cortisol production following a social stressor test was not related to stress-induced food intake in the laboratory. Previous reports have shown that high cortisol reactors consume more snacks than low cortisol reactors following a laboratory stressor (Epel et al., 2001), but Study Six did not replicate this finding. However, high cortisol reactors showed a significant relationship between the number of daily hassles and snack intake in the field. With a greater number of reported hassles, greater numbers of snacks were consumed in high reactors. This relationship was not observed within the low cortisol reactors. Therefore, Study Six provided strong



support for a cortisol reactivity mechanism of stress-induced eating, where high cortisol reactors are more susceptible to increased snack intake than low cortisol reactors.

Furthermore, coping style appeared to moderate the relationship between daily hassles and snack intake in high reactors, so that both active and emotional coping styles weakened the association, but avoidance coping did not change the relationship. Previous studies have reported that active and emotional coping are effective coping strategies (Carver et al., 1989) while avoidance coping may lead to helplessness and ineffective problem solving (Lyne & Roger, 2000; O'Connor & O'Connor, 2003). The results from this study suggest that high use of emotional coping style in particular may also prevent an eating response to stress.

No previous studies have tested the relationship between cortisol reactivity and intake in the field for comparison. However, the field findings from Study Six do lend support to the relationship between cortisol reactivity and intake reported in the laboratory (Epel et al., 2001). The results also support Sapolsky's (1998) theory that stress may induce food intake due to the release of glucocorticoids. Previous studies have linked administration of glucocorticoids to energy intake (Tataranni et al., 1996), but the findings from this study further suggest that the release of glucocorticoids during stress is also associated with increased intake, not just their administration.

The results from Study Six showed that hassles were associated with the increased intake of fruit, sweets and chocolate intake in particular. These results correspond well with previous reports of increased intake of sweet foods in rats (Laugero, 2001) and humans (Epel et al., 2001) when glucocorticoid levels are raised. Together, the findings suggest that the release of glucocorticoids during stress stimulates appetite both in the laboratory and field, and that the intake of sweet or high-energy foods is particularly stimulated. This association between stress and intake has particular implications for the development of central obesity, since eating when glucocorticoids are high can result in the deposition of fat around the abdomen (Bjortntorp, 2001). Therefore, it is possible that stress-induced eating promotes central obesity; though this is a difficult theory to test. A further unanswered

question is whether glucocorticoids have a direct effect on appetite, or whether the effect is actually mediated by the release of leptin or neuropeptide Y (Epel et al., 2001). This is therefore an important question that future research should address.

### **5.5 Implications of findings**

The findings from Studies One to Six provide several theoretical implications. First, it appears that stress per se may not lead to increased food intake, but rather the experience of ego threatening, interpersonal and work-related hassles relates to increased snack intake. Therefore stressor type plays an important role in predicting the relationship between stress and food intake. Second, the results reported here also suggest that certain personality factors could predispose individuals to develop eating style characteristics that are already associated with increased intake during stress. In particular, conscientiousness and perfectionism may impact upon the development of different types of restraint, which are differentially associated with the stress-eating relationship. Third, the studies presented in the thesis suggest that both psychological and physiological factors predict eating response to stress. Cortisol reactivity, coping style and changes in attention during stress could all contribute to whether or not food intake is increased when stressors are experienced and should be considered in a complete theoretical account of stress-induced eating.

The studies presented in this thesis highlight a number of methodological implications. First, the individual differences approach is more appropriate to the study of stress-induced eating, as Greeno and Wing (1994) also reported. Second, that stress-induced eating may be better tested within the field, using naturalistic studies, rather than in the laboratory. Third, the use of hierarchical linear modelling means that it is possible to study daily associations between stress and intake, which is particularly useful for monitoring the relationship between stress and intake in the field. Therefore, future research should aim to test the relationship between daily hassles and food intake in the field for a valid approach to the study of stress and eating. Finally, the findings from the studies have a practical implication for the availability of snack foods. The increased consumption of unhealthy foods, like crisps and chocolate, during stress suggests that healthier snacks could be made more widely available.



## 5.6 Conclusions

Stress does not have a uniform effect on food intake. Emotional eating and gender particularly appear to moderate the relationship, such that increased consumption is more prevalent in females, and high emotional eaters. While personality variables may not moderate the relationship between stress and eating by themselves, perfectionism and conscientiousness could predispose individuals to developing eating styles that are associated with increased food intake, and introversion could increase stress reactivity, and promote subsequent intake. Increases in food intake appear to be more likely when individuals are exposed to ego threatening, interpersonal and work-related stress, but physical stressors could increase consumption in external and emotional eaters and disinhibitors, who are already vulnerable to stress-induced eating. The intake of fruit, sweets and chocolates and crisps and nuts is particularly liable to change with stress, which could reflect an increased desire for energy-rich foods when stressed.

The underlying mechanisms of stress-induced eating appear to involve both psychological and physiological factors. Those individuals who are high cortisol reactors to stress show a stronger relationship between daily hassles and increased snack intake, though the use of active and emotional coping strategies weakens this relationship. However, further research is required to test whether cortisol has a direct effect on appetite, or whether it is mediated by other substrates. There is also evidence that attentional biases towards food stimuli during stress could account for stress-induced eating in external eaters. There is evidence that high external eaters attend towards unhealthy or snack food stimuli when stressed, which could explain increased intake in a subgroup that eats in response to food cues. However, this bias is likely to be conscious rather than preconscious. Further research is required to test whether external eaters also show biases towards food images or smells during stress for a more complete understanding of an attentional orienting to food-related stimuli during stress.

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APPENDIX 2.1

EATING QUESTIONNAIRE

I am currently investigating eating habits within the student population. As part of this research, I am collecting some questionnaire data about eating behaviour. I would be very grateful if you could spare a few minutes to complete this questionnaire. Your responses will be confidential, and you will not be asked to give your name. If you provide your email address, you may be contacted again to take part in a further study. However, completing this questionnaire and giving your email address does not mean that you have consented to take part in any future research.

Please provide the following details:

Age: \_\_\_\_\_Gender: \_\_\_\_\_

Height: \_\_\_\_\_Weight: \_\_\_\_\_

Email address: \_\_\_\_\_

Are you currently on a diet? Y/N (please delete as appropriate)

When you are stressed, would you say that your food intake is:

Much more than usual☐

More than usual☐

The same as usual☐

Less than usual☐

Much less than usual☐

(Please tick the appropriate box.)

When you are stressed, would you say that your intake of snacks is:

Much more than usual☐

More than usual☐

The same as usual☐

Less than usual☐

Much less than usual☐

Please rate how stressed you felt yesterday:

Not at all stressed1234567Extremely stressed

What foods did you eat between meals yesterday? Please list

Please report in the boxes any stressors or hassles that you experienced yesterday, and indicate how intense these were by circling the appropriate numbers on the right.

|    |                                      |
|----|--------------------------------------|
| 1. | Not at all    very much<br>0 1 2 3 4 |
| 2. | Not at all    very much<br>0 1 2 3 4 |
| 3. | Not at all    very much<br>0 1 2 3 4 |
| 4. | Not at all    very much<br>0 1 2 3 4 |
| 5. | Not at all    very much<br>0 1 2 3 4 |

Please answer the following questions as carefully and honestly as possible. Read each question and simply fill in the column which best applies to you.

|  | Never                 | Seldom                | Sometime              | Often                 | Very often            |
|--|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| 1 If you have put on weight, do you eat less than you usually do?                            | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 2 Do you have a desire to eat when you are irritated?  | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 3 If food tastes good to you, do you eat more than you usually do?                           | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 4 Do you try and eat less at meal times than you would like to eat?                          | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 5 Do you have a desire to eat when you have nothing to do?                                   | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 6 Do you have a desire to eat when you are fed up?   | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 7 If food smells and looks good, do you eat more than you usually do?                        | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 8 How often do you refuse food or drink offered because you are worried about how you weigh? | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 9 Do you have a desire to eat when you are feeling lonely?                                   | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 10 If you see or smell something delicious, do you have a desire to eat it?                  | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |



|    |   |                       |                       |                       |                       |                       |
|----|---|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| 11 | Do you watch exactly what you eat?  | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
|    |   | Never                 | Seldom                | Sometimes             | Often                 | Very often            |
| 12 | Do you have a desire to eat when somebody disappoints you?                                    | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 13 | If you have something delicious to eat, do you eat it straight away?                          | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 14 | Do you deliberately eat foods that are slimming?  | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 15 | Do you have a desire to eat when you are cross?   | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 16 | Do you have a desire to eat when you are expecting something to happen?                       | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 17 | If you walk past the baker do you have a desire to buy something delicious?                   | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 18 | When you have eaten too much, do you eat less than usual on the following days?               | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 19 | Do you get a desire to eat when you are anxious, worried or tense?                            | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 20 | If you walk past a snack bar or café, do you have a desire to eat something delicious?        | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 21 | Do you deliberately eat less in order not to become heavier?                                  | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 22 | Do you have a desire to eat when things are going against you or when things have gone wrong? | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 23 | If you see others eating, do you also have a desire to eat?                                   | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 24 | How often do you try not to eat between meals because you are watching your weight?           | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 25 | Do you have a desire to eat when you are frightened?  | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 26 | Can you resist eating delicious foods?  | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 27 | How often in the evening do you try not to eat because you are watching your weight?          | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 28 | Do you have a desire to eat when you are disappointed?  | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 29 | Do you eat more than usual when you see others eating?  | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 30 | Do you think about how much you weigh before deciding how much to eat?                        | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 31 | Do you have a desire to eat when you are upset?   | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 32 | When you see someone preparing a meal, does it make you want to eat something?                | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 33 | Do you have a desire to eat when you are bored or restless?                                   | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

Please decide whether the following statements are true or false about you, and circle the appropriate letter.

|  |   |   |
|--|---|---|
| When I smell a sizzling steak or see a juicy piece of meat, I find it very difficult to keep from eating, even if I have just finished a meal. | T | F |
| I usually eat too much at social occasions, like parties and picnics.  | T | F |
| Sometimes things just taste so good that I keep on eating even when I am no longer hungry.   | T | F |

|  |   |   |
|--|---|---|
| When I feel anxious I find myself eating.  | T | F |
| Since my weight goes up and down, I have gone on reducing diets more than once.                              | T | F |
| When I am with someone who is overeating, I usually overeat too.   | T | F |
| Sometimes when I start eating, I just can't seem to stop.  | T | F |
| It is not difficult for me to leave something on my plate.   | T | F |
| When I feel blue, I often overeat.   | T | F |
| My weight has hardly changed at all in the last two years.   | T | F |
| When I feel lonely, I console myself by eating.  | T | F |
| Without even thinking about it, I take a long time to eat.   | T | F |
| While on a diet, if I eat a food that is not allowed, I often then splurge and eat other high calorie foods. | T | F |

Below are phrases describing people's behaviours. Please use the rating scale below to describe how accurately each statement describes you. Please read each statement carefully and circle the appropriate number on the scale. Do not leave any blank.

| SCALE | 1               | 2                     | 3                              | 4                   | 5             |
|-------|-----------------|-----------------------|--------------------------------|---------------------|---------------|
|       | Very Inaccurate | Moderately Inaccurate | Neither Inaccurate or Accurate | Moderately Accurate | Very Accurate |

|                                |   |   |   |   |   |
|--------------------------------|---|---|---|---|---|
| I am relaxed most of the time. | 1 | 2 | 3 | 4 | 5 |
| Seldom feel blue.              | 1 | 2 | 3 | 4 | 5 |
| Get stressed out easily.       | 1 | 2 | 3 | 4 | 5 |
| Worry about things.            | 1 | 2 | 3 | 4 | 5 |
| Am easily disturbed.           | 1 | 2 | 3 | 4 | 5 |
| Get upset easily.              | 1 | 2 | 3 | 4 | 5 |
| Change my mood a lot.          | 1 | 2 | 3 | 4 | 5 |
| Have frequent mood swings.     | 1 | 2 | 3 | 4 | 5 |
| Get irritated easily.          | 1 | 2 | 3 | 4 | 5 |
| Often feel blue.               | 1 | 2 | 3 | 4 | 5 |

Thank you very much for taking the time to complete this questionnaire.



## APPENDIX 2.2

Approval for project title.....STRESS & EATING.....

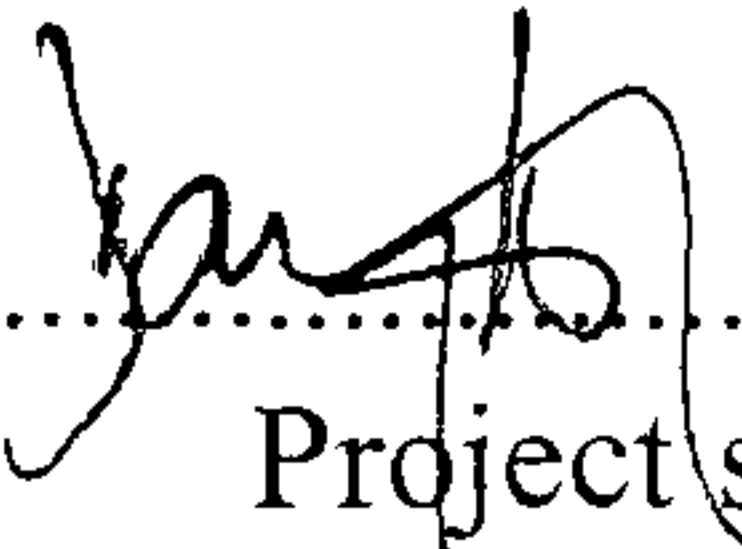
.....QUESTIONNAIRE.....


Investigator.....EMILY NEWMAN.....

Supervisor.....DARYL O'CONNOR & MARK CONNOR.....

### 1) Undergraduate and postgraduate research projects


The project supervisor has read this form and affirms that appropriate ethical safeguards are in place:

Signature .....Date.....19/7/04.....  
Project supervisor

Block Capitals DARYL O'CONNOR.....

### 2) Postgraduate, research and academic staff research projects


The postgraduate/researcher/academic who is conducting this research has read this form and affirms that appropriate ethical safeguards are in place:

Signature .....Date.....10.01.2003.....  
Postgraduate/researcher/academic

Block Capitals EMILY NEWMAN.....

### Chair of the School of Psychology Ethics Committee

The School Ethics Committee, or Chair of the School Ethics Committee as representative of the Ethics Committee, has read this form and affirms that appropriate ethical safeguards are in place:

Signature .....Date.....26/07/04.....  
Chair of the School of Psychology Ethics Committee

Block Capitals S. O'CONNOR.....



APPENDIX 2.3

Confirmation of Ethical Safeguards

Undergraduate and postgraduate research projects

The project supervisor has read this form and affirms that appropriate ethical safeguards are in place:

Signature [Signature] Date 1/7/05  
Project Supervisor  
Block Capitals DARYL O'CONNOR

Postgraduate, research and academic staff research projects

The postgraduate/researcher/academic who is conducting this research has read this form and affirms that appropriate ethical safeguards are in place:

Signature E. Ne Date 23.06.2005  
Postgraduate/Researcher/Academic  
Block Capitals EMILY NEWMAN

Authorisation of Ethics Form

Institute of Psychological Ethics Committee

The Institute Ethics Committee, or Chair of the Departmental Ethics Committee as representative of the Ethics Committee, has read this form and affirms that appropriate ethical safeguards are in place:

Signature [Signature] Date 1/7/05  
Chair (or representative) of the  
Institute of Psychological Sciences Ethics Committee  
Block Capitals [Signature]

Additional Feedback (if applicable)



**APPENDIX 2.4****INFORMATION ABOUT YOU**

Gender M/F (please delete as appropriate)

Age\_\_\_\_\_

Height \_\_\_\_\_

Weight\_\_\_\_\_

Current occupation \_\_\_\_\_

Years in education \_\_\_\_\_

What is your highest qualification? \_\_\_\_\_

Are you vegetarian? Y/N (please delete as appropriate)

Are you vegan? Y/N (please delete as appropriate)

Do you have any other dietary requirements? Y/N (please delete as appropriate)

If yes, please specify:

---

---

---

Are you currently on a diet (i.e. are you trying to lose weight)? Y/N (please delete as appropriate)

DAY ONE

Today's date: \_\_\_\_\_

1. Please report any foods that you ate **between meals** today, and when you ate them. Please then rate how healthy and high in sugar and fat you think each snack was by circling the appropriate number on the scale in each box.

|            |           |             |             |               |               |   |   |
|------------|-----------|-------------|-------------|---------------|---------------|---|---|
| 1          |           |             |             | Time:         |               |   |   |
| Healthy    |           | High in fat |             | High in sugar |               |   |   |
| Not at all | very much | Not at all  | very much   | Not at all    | very much     |   |   |
| 1          | 2         | 3           | 4           | 1             | 2             | 3 | 4 |
|            |           |             |             | Time:         |               |   |   |
| 2          | Healthy   |             | High in fat |               | High in sugar |   |   |
| Not at all | very much | Not at all  | very much   | Not at all    | very much     |   |   |
| 1          | 2         | 3           | 4           | 1             | 2             | 3 | 4 |
|            |           |             |             | Time:         |               |   |   |
| 3          | Healthy   |             | High in fat |               | High in sugar |   |   |
| Not at all | very much | Not at all  | very much   | Not at all    | very much     |   |   |
| 1          | 2         | 3           | 4           | 1             | 2             | 3 | 4 |
|            |           |             |             | Time:         |               |   |   |
|            |           |             |             | Time:         |               |   |   |
| Healthy    |           | High in fat |             | High in sugar |               |   |   |
| Not at all | very much | Not at all  | very much   | Not at all    | very much     |   |   |
| 1          | 2         | 3           | 4           | 1             | 2             | 3 | 4 |
|            |           |             |             | Time:         |               |   |   |
| 5          | Healthy   |             | High in fat |               | High in sugar |   |   |
| Not at all | very much | Not at all  | very much   | Not at all    | very much     |   |   |
| 1          | 2         | 3           | 4           | 1             | 2             | 3 | 4 |
|            |           |             |             | Time:         |               |   |   |
|            |           |             |             | Time:         |               |   |   |
| Healthy    |           | High in fat |             | High in sugar |               |   |   |
| Not at all | very much | Not at all  | very much   | Not at all    | very much     |   |   |
| 1          | 2         | 3           | 4           | 1             | 2             | 3 | 4 |

2. Please use the tick boxes below to indicate whether you feel you have eaten more/less than you usually do for the following meals

|                          |                          |                          |                          |                          |
|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Less than usual          | Same as usual            | More than usual          | Did not eat today        | Never eat this           |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Breakfast                | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Morning snacks           | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Lunch                    | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Afternoon snacks         | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Evening meal             | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Evening snacks           | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

3. Please report in the boxes below any hassles that you experienced today. Please then provide a rating for intensity, how much it is related to each hassle type and its controllability by circling the appropriate number in each box. Please provide a rating for EACH of these.

|                 |                     |                  |                 |                 |                 |                 |                 |
|-----------------|---------------------|------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| 1.              |                     |                  |                 |                 |                 |                 |                 |
| Intensity       | Health/body-related | Feelings-related | Person-related  | Work-related    | Time-related    | Control         |                 |
| Not very at all | Not very at all     | Not very at all  | Not very at all | Not very at all | Not very at all | Not very at all | Not very at all |
| much            | much                | much             | much            | much            | much            | much            | much            |
| 1               | 1                   | 1                | 1               | 1               | 1               | 1               | 1               |
| 2               | 2                   | 2                | 2               | 2               | 2               | 2               | 2               |
| 3               | 3                   | 3                | 3               | 3               | 3               | 3               | 3               |
| 4               | 4                   | 4                | 4               | 4               | 4               | 4               | 4               |
| 2.              |                     |                  |                 |                 |                 |                 |                 |
| 3.              |                     |                  |                 |                 |                 |                 |                 |
| Intensity       | Health/body-related | Feelings-related | Person-related  | Work-related    | Time-related    | Control         |                 |
| Not very at all | Not very at all     | Not very at all  | Not very at all | Not very at all | Not very at all | Not very at all | Not very at all |
| much            | much                | much             | much            | much            | much            | much            | much            |
| 1               | 1                   | 1                | 1               | 1               | 1               | 1               | 1               |
| 2               | 2                   | 2                | 2               | 2               | 2               | 2               | 2               |
| 3               | 3                   | 3                | 3               | 3               | 3               | 3               | 3               |
| 4               | 4                   | 4                | 4               | 4               | 4               | 4               | 4               |
| 4.              |                     |                  |                 |                 |                 |                 |                 |
| Intensity       | Health/body-related | Feelings-related | Person-related  | Work-related    | Time-related    | Control         |                 |
| Not very at all | Not very at all     | Not very at all  | Not very at all | Not very at all | Not very at all | Not very at all | Not very at all |
| much            | much                | much             | much            | much            | much            | much            | much            |
| 1               | 1                   | 1                | 1               | 1               | 1               | 1               | 1               |
| 2               | 2                   | 2                | 2               | 2               | 2               | 2               | 2               |
| 3               | 3                   | 3                | 3               | 3               | 3               | 3               | 3               |
| 4               | 4                   | 4                | 4               | 4               | 4               | 4               | 4               |
| 5.              |                     |                  |                 |                 |                 |                 |                 |
| Intensity       | Health/body-related | Feelings-related | Person-related  | Work-related    | Time-related    | Control         |                 |
| Not very at all | Not very at all     | Not very at all  | Not very at all | Not very at all | Not very at all | Not very at all | Not very at all |
| much            | much                | much             | much            | much            | much            | much            | much            |
| 1               | 1                   | 1                | 1               | 1               | 1               | 1               | 1               |
| 2               | 2                   | 2                | 2               | 2               | 2               | 2               | 2               |
| 3               | 3                   | 3                | 3               | 3               | 3               | 3               | 3               |
| 4               | 4                   | 4                | 4               | 4               | 4               | 4               | 4               |



4. Please rate how much of a HASSLE (irritant) and how much of an UPLIFT (makes you feel good or satisfied) each item below was for you today. Please indicate on the left hand side how much of a hassle the item was by circling the appropriate number. Then indicate on the right hand side how much of an uplift it was for you by circling the appropriate number. Circle one number on the left-hand side and one number on the right-hand side for each item.

Please use the following scale.

0= none, or not applicable

1=somewhat

2= quite a bit

3= a great deal

| Hassle  | Item  | Uplift  |
|---------|---|---------|
| 0 1 2 3 | 1. Your child(ren)  | 0 1 2 3 |
| 0 1 2 3 | 2. Your parents/parents in law  | 0 1 2 3 |
| 0 1 2 3 | 3. Other relative(s)  | 0 1 2 3 |
| 0 1 2 3 | 4. Your spouse  | 0 1 2 3 |
| 0 1 2 3 | 5. Time spent with family   | 0 1 2 3 |
| 0 1 2 3 | 6. Health or well-being of a family member  | 0 1 2 3 |
| 0 1 2 3 | 7. Sex  | 0 1 2 3 |
| 0 1 2 3 | 8. Intimacy   | 0 1 2 3 |
| 0 1 2 3 | 9. Family-related obligations   | 0 1 2 3 |
| 0 1 2 3 | 10. Your friend(s)  | 0 1 2 3 |
| 0 1 2 3 | 11. Fellow workers  | 0 1 2 3 |
| 0 1 2 3 | 12. Clients, customers, patients, etc   | 0 1 2 3 |
| 0 1 2 3 | 13. Your supervisor/ employer   | 0 1 2 3 |
| 0 1 2 3 | 14. The nature of your work   | 0 1 2 3 |
| 0 1 2 3 | 15. Your workload   | 0 1 2 3 |
| 0 1 2 3 | 16. Your job security   | 0 1 2 3 |
| 0 1 2 3 | 17. Meeting deadlines or goals on the job   | 0 1 2 3 |
| 0 1 2 3 | 18. Enough money for necessities e.g. food, clothing, housing, healthcare, taxes, insurance | 0 1 2 3 |
| 0 1 2 3 | 19. Enough money for education  | 0 1 2 3 |
| 0 1 2 3 | 20. Enough money for emergencies  | 0 1 2 3 |
| 0 1 2 3 | 21. Enough money for extras e.g. entertainment, recreation, vacations                       | 0 1 2 3 |
| 0 1 2 3 | 22. Financial care for someone who doesn't live with you                                    | 0 1 2 3 |

0= none, or not applicable

1=somewhat

2= quite a bit

3= a great deal

| Hassle  | Item   | Uplift  |
|---------|--|---------|
| 0 1 2 3 | 23. Investments  | 0 1 2 3 |
| 0 1 2 3 | 24. Your smoking   | 0 1 2 3 |
| 0 1 2 3 | 25. Your drinking  | 0 1 2 3 |
| 0 1 2 3 | 26. Mood-altering drugs  | 0 1 2 3 |
| 0 1 2 3 | 27. Your physical appearance   | 0 1 2 3 |
| 0 1 2 3 | 28. Contraception  | 0 1 2 3 |
| 0 1 2 3 | 29. Exercise(s)  | 0 1 2 3 |
| 0 1 2 3 | 30. Your medical care  | 0 1 2 3 |
| 0 1 2 3 | 31. Your health  | 0 1 2 3 |
| 0 1 2 3 | 32. Your physical abilities  | 0 1 2 3 |
| 0 1 2 3 | 33. The weather  | 0 1 2 3 |
| 0 1 2 3 | 34. News events  | 0 1 2 3 |
| 0 1 2 3 | 35. Your environment e.g. the quality of air, noise level, greenery                        | 0 1 2 3 |
| 0 1 2 3 | 36. Political or social issues   | 0 1 2 3 |
| 0 1 2 3 | 37. Your neighbourhood e.g. neighbours, setting  | 0 1 2 3 |
| 0 1 2 3 | 38. Conserving (gas, electricity, water, petrol etc)                                       | 0 1 2 3 |
| 0 1 2 3 | 39. Pets   | 0 1 2 3 |
| 0 1 2 3 | 40. Cooking  | 0 1 2 3 |
| 0 1 2 3 | 41. Housework  | 0 1 2 3 |
| 0 1 2 3 | 42. Home repairs   | 0 1 2 3 |
| 0 1 2 3 | 43. Gardening  | 0 1 2 3 |
| 0 1 2 3 | 44. Car maintenance  | 0 1 2 3 |
| 0 1 2 3 | 45. Taking care of paperwork e.g. paying bills, filling in forms                           | 0 1 2 3 |
| 0 1 2 3 | 46. Home entertainment e.g. TV, music, reading   | 0 1 2 3 |
| 0 1 2 3 | 47. Amount of free time  | 0 1 2 3 |
| 0 1 2 3 | 48. Recreation and entertainment outside the home e.g. movies, sports, eating out, walking | 0 1 2 3 |
| 0 1 2 3 | 49. Eating (at home)   | 0 1 2 3 |
| 0 1 2 3 | 50. Church or community organisations  | 0 1 2 3 |
| 0 1 2 3 | 51. Legal matters  | 0 1 2 3 |
| 0 1 2 3 | 52. Being organised  | 0 1 2 3 |
| 0 1 2 3 | 53. Social commitments   | 0 1 2 3 |

5. Below is a list of feelings/emotions. Please indicate to what extent you have felt this way today by circling the appropriate answer for each word.

|              | <i>Very<br/>slightly/<br/>not at all</i> | <i>A<br/>little</i> | <i>Moderately</i> | <i>Quite a<br/>bit</i> | <i>Extremely</i> |
|--------------|--|---------------------|-------------------|------------------------|------------------|
| Enthusiastic | 1  | 2                   | 3                 | 4                      | 5                |
| Afraid       | 1  | 2                   | 3                 | 4                      | 5                |
| Excited      | 1  | 2                   | 3                 | 4                      | 5                |
| Inspired     | 1  | 2                   | 3                 | 4                      | 5                |
| Upset        | 1  | 2                   | 3                 | 4                      | 5                |
| Alert        | 1  | 2                   | 3                 | 4                      | 5                |
| Distressed   | 1  | 2                   | 3                 | 4                      | 5                |
| Determined   | 1  | 2                   | 3                 | 4                      | 5                |
| Nervous      | 1  | 2                   | 3                 | 4                      | 5                |
| Scared       | 1  | 2                   | 3                 | 4                      | 5                |

6. How stressed did you feel today? (Please circle)

|            |   |   |   |   |   |           |
|------------|---|---|---|---|---|-----------|
| 1          | 2 | 3 | 4 | 5 | 6 | 7         |
| Not at all |   |   |   |   |   | Extremely |

7. How pressured did you feel today? (please circle)

|            |   |   |   |   |   |           |
|------------|---|---|---|---|---|-----------|
| 1          | 2 | 3 | 4 | 5 | 6 | 7         |
| Not at all |   |   |   |   |   | Extremely |

8. How in control did you feel today?

|            |   |   |   |   |   |           |
|------------|---|---|---|---|---|-----------|
| 1          | 2 | 3 | 4 | 5 | 6 | 7         |
| Not at all |   |   |   |   |   | Extremely |

9. How hungry did you feel today? (please circle)

|            |   |   |   |   |   |           |
|------------|---|---|---|---|---|-----------|
| 1          | 2 | 3 | 4 | 5 | 6 | 7         |
| Not at all |   |   |   |   |   | Extremely |

10. How many hours of paid work have you done today? \_\_\_\_\_

11. How many hours of unpaid work have you done today? \_\_\_\_\_

12. How many units of alcohol have you consumed today? \_\_\_\_\_

13. How many cigarettes have you smoked today? \_\_\_\_\_

14. Have you had any cravings for particular foods today? Y/N

If so, please list craved foods: \_\_\_\_\_



### APPENDIX 3.1

Approval for project title...STROOP & DOT PROBE!...

...ATTENTIONAL BIASES FOR FOOD STIMULI...

Investigator...EMILY NEWMAN...

Supervisor...DARYL O'CONNOR, MARK CONNER...

#### 1) Undergraduate and postgraduate research projects

The project supervisor has read this form and affirms that appropriate ethical safeguards are in place:

Signature ..... Date...17/12/02

Project supervisor

Block Capitals...DARYL O'CONNOR...

#### 2) Postgraduate, research and academic staff research projects

The postgraduate/researcher/academic who is conducting this research has read this form and affirms that appropriate ethical safeguards are in place:

Signature E. Newman ..... Date...16.12.2002

Postgraduate/researcher/academic

Block Capitals...EMILY NEWMAN...

#### Chair of the School of Psychology Ethics Committee

The School Ethics Committee, or Chair of the School Ethics Committee as representative of the Ethics Committee, has read this form and affirms that appropriate ethical safeguards are in place:

Signature...B Goughm ..... Date...07/07/03

Chair of the School of Psychology Ethics Committee

Block Capitals...B Goughm...

**APPENDIX 3.2****STROOP WORDS**

25 words in each of four categories. Categories include: neutral; ego-threat; unhealthy and healthy foods.

| <b>Neutral</b> | <b>Ego-threat</b> | <b>Unhealthy</b> | <b>healthy</b> |
|----------------|-------------------|------------------|----------------|
| Jersey         | Lonely            | Cheese           | Cereal         |
| Batteries      | Worthless         | Shortcake        | pineapple      |
| Quantity       | Rejected          | Icecream         | Potatoes       |
| Waterproof     | Humiliated        | Croissants       | Courgettes     |
| Multitude      | Powerless         | Chocolate        | Aubergine      |
| Transition     | Inadequate        | Cheesecake       | Watermelon     |
| Shearing       | Inferior          | Sausages         | Mushroom       |
| Mythology      | Tormented         | Milkshake        | Sweetcorn      |
| Feathers       | Hopeless          | Pancakes         | Apricots       |
| Cleaners       | Pathetic          | Crackers         | Cucumber       |
| Varied         | Threat            | Cookie           | Pepper         |
| Cities         | Stress            | Sweets           | Banana         |
| Core           | Hurt              | Pies             | Beef           |
| Check          | Enemy             | Pizza            | Bread          |
| Fetching       | Insecure          | Tiramisu         | Broccoli       |
| Bridges        | Unhappy           | Biscuit          | Chicken        |
| Creature       | Distress          | Doughnut         | Tomatoes       |
| Coefficient    | Intimidated       | Profiterole      | Cauliflower    |
| Planet         | Scared            | Crisps           | Grapes         |
| Parked         | Suffer            | Burger           | Carrot         |
| Lighted        | Ignored           | Caramel          | Yoghurt        |
| Pastel         | Gloomy            | Toffee           | Onions         |
| Aisle          | Tease             | Chips            | Salad          |
| Connections    | Discouraged       | Gingerbread      | Raspberries    |
| Wagons         | Horror            | Hotdog           | Salmon         |



### APPENDIX 3.3

#### **DOT PROBE WORDS**

Cheese – Jersey

Cereal – Adjust

Shortcake – Batteries

Pineapple – Furniture

Icecream – Quantity

Potatoes – Recorded

Croissants – Waterproof

Courgettes – Stagecoach

Chocolate – Multitude

Aubergine – Variables

Cheesecake – Transition

Watermelon – Reclaiming

Sausages – Shearing

Mushroom – Textured

Milkshake – Mythology

Sweetcorn – Signature

Pancakes – Feathers

Apricots – Delegate

Crackers – Cleaners

Cucumber – Requests

Cookie – Varied

Pepper – Junior

Sweets – Cities

Banana – Recall

Pies – Core

Beef – Crew

Pizza – Check

Bread – Inner

Tiramisu – Softener

Broccoli – Fetching

Biscuit – Bridges

Chicken – Content

Doughnut – Creature

Tomatoes – Integral

Profiterole – Coefficient

Cauliflower – Approximate

Crisps – Planet

Grapes – Handle

Burger – Parked

Carrot – Campus

Yoghurt – Remarks

Toffee – Pastel

Onions – Confer

Chips – Aisle

Salad – Dried

Gingerbread – Connections

Raspberries – Constituent

Hotdog – Wagons

Salmon – Tokens

**APPENDIX 3.4**

Below there is a list of ten topics. You will be given ten minutes in which to prepare a speech about your opinion on one of these topics. You may use the pen and paper provided to help you. After the computer-based tasks, you will be asked to perform a speech (lasting approximately four minutes), which will be recorded using a video-camera. Your performance will later be analysed by a group of psychologists who are experts in non-verbal communication.

What is your opinion about one of the following topics:

1. Euthanasia
2. Animal testing
3. Abortion
4. Violence on television
5. Censorship
6. Cannabis legalisation
7. Fox hunting
8. Sexual Inequality



## APPENDIX 3.5

### Study Four dot probe word pairs

#### 14ms

yoghurt,pilgrim  
melon,stile  
ricecakes,astronaut  
olives,parson  
strawberries,candlestick  
biscuit,garment  
scone,tenet  
flapjack,pentagon  
muffin,abacus  
marshmallows,steepchase  
chicken,ceiling  
prawns,banner  
aubergine,causality  
muesli,jigsaw  
cauliflower,coefficient  
nuggets,garland  
pizza,copse  
friedrice,aptitude  
pasty,camel  
frenchfries,weathervane  
steamer,homous  
pitch,apple  
vestibule,pineapple  
saloon,walnut  
steorage,crudites  
locator,toffees  
gutter,crisps  
creatures,chocolate  
midday,mousse  
parlours,lollipop  
creases,noodles  
array,salad  
artefacts,mushrooms  
bricks,pepper  
watchers,cucumber  
plinths,samosas  
badge,curry  
aspidistra,enchilada  
topsoil,lasagne  
logician,tiramisu

#### 500ms

satsuma,planter  
bagel,tempo  
currants,networks  
grapes,tandem  
crispbread,blackboard  
popcorn,spanner  
eclair,foible  
teacakes,pianist  
sweets,locker  
creamcake,apprentice  
lentils,figment  
leeks,quest  
potatoes,position  
cereal,tripod  
courgettes,tambourine  
stirfry,tempest  
steak,vinyl  
sausages,panorama  
burger,rattle  
croissants,stagecoach  
ledgers,berries  
font,figs  
projector,nectarine  
input,seeds  
checkout,apricots  
dormice,jamtart  
dust,cake  
excerpts,cupcakes  
glance,cheese  
lettings,doughnut  
tableau,sprouts  
seam,tuna  
videotape,sweetcorn  
pence,beans  
curators,broccoli  
tannoy,quiche  
malls,kebab  
cyclamen,macaroni  
shade,bacon  
shortwave,moussaka

#### 1000ms

raisins,slipper  
toast,guild  
brazilnut,traction  
banana,replay  
breadsticks,opportunity  
peanuts,capsule  
crepe,spire  
swissroll,watermill  
cookie,simile  
gingerbread,broomstick  
carrots,enzymes  
pasta,porch  
casserole,nightfall  
paella,portal  
beansprouts,periodical  
waffles,recital  
chips,cliff  
hashbrown,accordion  
scampi,piston  
springrolls,sandcastles  
downtown,crackers  
kerb,pear  
stallion,cherries  
script,orange  
campervan,cerealbar  
adhesion,brownies  
hoops,fudge  
gazelles,icecream  
loafer,nachos  
sunglasses,shortcake  
trainers,tomatoes  
pole,soup  
radiance,omelette  
shrine,onions  
stairwell,asparagus  
deftness,fritters  
mast,pies  
resealed,steakpie  
bangle,panini  
paragliders,garlicbread

**Study Five dot probe**  
**image pairs**

**14ms**

yoghurt,cottonbuds  
melon,cloth  
ricecakes,files  
olives,earphones  
strawberries,h  
biscuit,glove  
scone,aftershave  
flapjack,batteries  
muffin,box  
marshmallows,ca  
chicken,doorhandle  
prawns,keyboard  
aubergine,monitor  
muesli,postcard  
cauliflower,sink  
nuggets,mousecomp  
pizza,newspaper  
friedrice,sponge  
pasty,stamps  
frenchfries,plants  
mag,homous  
mobile,apple  
paperpad,pineapple  
passport,walnuts  
rubikscube,crudites  
jewelbox,toffees  
holepunch,crisps  
trainticket,chocolate  
stickers,mousse  
toothbrush,lollipop  
ruler,noodles  
windmill,salad  
toy,mushrooms  
candle,pepper  
cup,cucumber  
hairband,samosas  
laptop,curry  
cardigan,enchiladas  
 earmuffs,lasagne  
taperecorder,tiramisu

**500ms**

satsumas,desktidy  
bagel,lightbulb  
currants,diary  
grapes,lead  
crispbread,scales  
popcorn,mug  
eclair,highlighter  
teacake,trainer  
sweets,leaflets  
creamcake,moisturiser  
lentils,cd  
leeks,plasticfolder  
potatoes,wool  
cereal,keys  
courgettes,lamp  
stirfry,towel  
steak,purse  
sausages,socket  
burger,papertoweldisp  
croissant,handbag  
umbrella,berries  
violin,figs  
tape,necatarine  
shampoo,seeds  
iron,apricots  
diskcarrier,jamtart  
fabriccond,cake  
speaker,cupcake  
chair,cheese  
pencil,doughnut  
remote,sprouts  
glass,tuna  
clock,sweetcorn  
calculator,beans  
cactus,broccoli  
bookmark,quiche  
boot,kebab  
bin,macaroni  
cards,bacon  
folder,moussaka

**1000ms**

raisins,sunglasses  
toast,rucksack  
brazilnuts,spectacles  
banana,toothpaste  
breadsticks,rubberglove  
peanuts,pencilcase  
crepe,belt  
swissroll,book  
cookie,disk  
gingerbread,fan  
carrots,bubblebath  
pasta,flowerorn  
casserole,videoplayer  
paella,scarf  
bransprouts,cardbox  
waffle,frenchdict  
chips,phone  
hashbrown,recyclingbin  
scampi,penholder  
springrolls,sellotape  
ipod,crackers  
oillamp,pear  
stopwatch,cherries  
tv,orange  
watch,cerealbar  
coathanger,brownies  
powderbrush,fudge  
racquet,icecream  
bulldogclip,nachos  
kettle,shortcake  
stapler,tomatoes  
camera,soup  
microphone,omelette  
comb,onions  
biro,asparagus  
washingupliq,fritters  
socks,pies  
tapemeasure,steakpie  
hangers,panini  
envelope,garlicbread



**APPENDIX 3.6****Study Four awareness words****Lexical decision pairs:**

stame,frake  
 paktion,briston  
 mambether,penstache  
 trield,sperk  
 besk,avex  
 cratten,gearson  
 yarden,dassel  
 muttle,parner  
 telvern,garbint  
 croad,trink  
 geffer,elsont  
 blintarn,ransting  
 figment,pitcher  
 cliff,spire  
 grapes,cheese  
 fudge,salad  
 garland,ceiling  
 berries,biscuit  
 input,camel  
 kerb,pole  
 badge,shade  
 crepe,fudge  
 cake,tuna  
 lentils,toffees

**Presence/absence pairs:**

melon,olives  
 tempo,quest  
 crisps,apple  
 bangle,portal  
 pasta,orange  
 array,copse  
 bacon,beans  
 locker,rattle  
 chicken,sprouts  
 seam,font  
 doughnut,tomatoes  
 replay,simile

**Study Five awareness images****Content discrimination pairs:**

apple,mushrooms  
 lollipop,marshmallows  
 nachos,olives  
 orange,moussaka  
 pizza,raisins  
 pepper,salad  
 sweetcorn,sausages  
 strawberries,muffin  
 biscuit,tuna  
 swissroll,yoghurt  
 samosas,quiche  
 icecream,grapes  
 handbag,glove  
 earphones,envelope  
 fan,cap  
 calculator,bin  
 camera,diskcarrier  
 folder,book  
 lamp,ipod  
 mousecomp,passport  
 racquet,postcard  
 rubikscube,scarf  
 speaker,spectacles  
 towel,trainer

**Presence/absence images:**

trainticket,umbrella  
 stirfry,scone  
 plants,pineapple  
 oillamp,paperpad  
 lasagne,kebab  
 keyboard,glass  
 gingerbread,fudge  
 earmuffs,fabriccond  
 crackers,cucumber  
 cardbox,bubblebath  
 beans,banana  
 biro,belt

DAY THREE

Today's date: \_\_\_\_\_

1. Below is a list of feelings/emotions. Please indicate to what extent you have felt this way today by circling the appropriate answer for each word.

|              | Very<br>slightly/<br>not at all | A<br>little | Moderately | Quite a<br>bit | Extremely |
|--------------|---------------------------------|-------------|------------|----------------|-----------|
| Enthusiastic | 1                               | 2           | 3          | 4              | 5         |
| Afraid       | 1                               | 2           | 3          | 4              | 5         |
| Excited      | 1                               | 2           | 3          | 4              | 5         |
| Inspired     | 1                               | 2           | 3          | 4              | 5         |
| Upset        | 1                               | 2           | 3          | 4              | 5         |
| Alert        | 1                               | 2           | 3          | 4              | 5         |
| Distressed   | 1                               | 2           | 3          | 4              | 5         |
| Determined   | 1                               | 2           | 3          | 4              | 5         |
| Nervous      | 1                               | 2           | 3          | 4              | 5         |
| Scared       | 1                               | 2           | 3          | 4              | 5         |

2. How stressed did you feel today? (Please circle)

1 2 3 4 5 6 7  
Not at all Extremely

3. How pressured did you feel today? (please circle)

1 2 3 4 5 6 7  
Not at all Extremely

4. How in control did you feel today?

1 2 3 4 5 6 7  
Not at all Extremely

5. How hungry did you feel today? (please circle)

1 2 3 4 5 6 7  
Not at all Extremely

6. How many hours of paid work have you done today? \_\_\_\_\_

7. How many hours of unpaid work have you done today? \_\_\_\_\_

8. Please report in the boxes below any hassles that you experienced today, and indicate how intense each of these was by circling the appropriate number on the right.

|    |  |               |              |
|----|--|---------------|--------------|
| 1. |  | Not at<br>all | Very<br>much |
| 2. |  | Not at<br>all | Very<br>much |
| 3. |  | Not at<br>All | Very<br>much |
| 4. |  | Not at<br>all | Very<br>much |
| 5. |  | Not at<br>all | Very<br>much |

9. Please report any foods that you ate between meals today, and when you ate them.

|   |  |       |
|---|--|-------|
| 1 |  | Time: |
| 2 |  | Time: |
| 3 |  | Time: |
| 4 |  | Time: |
| 5 |  | Time: |

10. Please use the tick boxes below to indicate whether you feel you have eaten more/less than usual for the following meals

|                  | Less<br>than<br>usual    | Same<br>as<br>usual      | More<br>than<br>usual    | Did not<br>eat<br>today  | Never<br>eat this        |
|------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Breakfast        | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Morning snacks   | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Lunch            | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Afternoon snacks | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Evening meal     | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Evening snacks   | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |



## APPENDIX 4.2

Approval for project title. CORTICAL REACTIVITY &

S.WACING STUDY

Investigator EMILY NEWMAN

Supervisor DARIL O'CONNOR & MARE CONNER

**1) Undergraduate and postgraduate research projects**

The project supervisor has read this form and affirms that appropriate ethical safeguards are in place:

Signature [Signature] Date 7/8/04 ✓  
Project supervisor

Block Capitals DARIL O'CONNOR

**2) Postgraduate, research and academic staff research projects**

The postgraduate/researcher/academic who is conducting this research has read this form and affirms that appropriate ethical safeguards are in place:

Signature [Signature] Date 30.07.2004  
Postgraduate/researcher/academic

Block Capitals EMILY NEWMAN

**Chair of the School of Psychology Ethics Committee**

The School Ethics Committee, or Chair of the School Ethics Committee as representative of the Ethics Committee, has read this form and affirms that appropriate ethical safeguards are in place:

Signature [Signature] Date 19/08/04  
Chair of the School of Psychology Ethics Committee

Block Capitals B. GORMAN

### APPENDIX 4.3

#### NUTRITIONAL VALUES OF SNACKS

Foods categorised as high and low fat, savoury and sweet.

High fat savoury= Pringles

High fat sweet= Cadbury's dairy milk

Low fat savoury= Breadsticks

Low fat sweet= Bassetts jelly babies

| Typical values<br>per 100g | Pringles | Dairy milk | Breadsticks | Jelly babies |
|----------------------------|----------|------------|-------------|--------------|
| Energy (KJ/<br>Kcal)       | 556.0    | 525.0      | 421.0       | 335.0        |
| Protein (g)                | 4.3      | 7.6        | 9.5         | 4.0          |
| Carbohydrate<br>(g)        | 48.0     | 56.4       | 72.5        | 79.5         |
| Fat (g)                    | 38.0     | 29.7       | 10.3        | Trace        |